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ABSTRACT

This document is intended to help education and training institutions deliver the Machine Tool Advanced Skills Technology (MAST) curriculum to a variety of individuals and organizations. MAST consists of industry-specific skill standards and model curricula for 15 occupational specialty areas within the U.S. machine tool and metals-related industries. This volume provides the MAST standards and curriculum for the welding specialty area. (A welder is a person who uses arc and gas, shielded metal arc welding (SMAW), gas metal arc welding, gas tungsten arc welding, brazing, metallurgy, and print interpretation to perform welding operations necessary to produce a workpiece to required standards.) This volume is organized in the following sections: (1) a profile of Moraine Valley Community College (Illinois), the development center that produced these standards and curriculum; (2) a welder competency profile of job duties and tasks; (3) a welder duty, task, and subtask outline; (4) a course curriculum outline and course descriptions; (5) a technical workplace competencies and course crosswalk; and (6) a Secretary's Commission on Achieving Necessary Skills (SCANS) proficiencies course crosswalk. Individual syllabi for the following courses are provided: Basic Arc/Gas Welding I-II; Electrical Welding Circuits; Reading Welding Blueprints; Advanced SMAW and Cutting I-II; Metal Inert Gas (MIG), Tungsten Inert Gas (TIG), and Brazing I-II; Basic Welding Metallurgy; Individual Welding Problems I-II; Basic Pipe Welding I-II; and Visual Inspection of Welds. Each course syllabus includes the following: course hours, course descriptions, prerequisites, required course materials, teaching and evaluation methods, lecture and laboratory outlines, course objectives for technical and SCANS competencies, and suggested references. Two appendixes contain industry competency profiles and the pilot program narrative. (KC)

ED 401 436

Machine Tool Advanced Skills Technology

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COMMON GROUND: TOWARD A STANDARDS-BASED TRAINING SYSTEM FOR THE U.S. MACHINE TOOL AND METAL RELATED INDUSTRIES

VOLUME 6

WELDING

of
a 15 volume set of Skills Standards
and
Curriculum Training Materials for the
PRECISION MANUFACTURING INDUSTRY

Supported by
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CACT CENTER FOR APPLIED COMPETITIVE TECHNOLOGIES
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Moraine Valley Community College

SPRINGFIELD TECHNICAL COMMUNITY COLLEGE

Texas State Technical College Waco

*M*achine Tool *A*dvanced *S*kills *T*echnology Program

MAST

VOLUME 6

-- WELDING --

Supported by
The Office of Vocational and Adult Education
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September, 1996

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This project was made possible by the cooperation and direct support of the following organizations:

- U.S. Department of Education, Office of Vocational & Adult Education
- MAST Consortia of Employers and Educators

MAST DEVELOPMENT CENTERS

Augusta Technical Institute - Itawamba Community College - Moraine Valley Community College - San Diego City College (CACT) - Springfield Technical Community College - Texas State Technical College

INDUSTRIES

AB Lasers - AIRCAP/MTD - ALCOA - American Saw - AMOCO Performance Products - Automatic Switch Company - Bell Helicopter - Bowen Tool - Brunner - Chrysler Corp. - Chrysler Technologies - Conveyor Plus - Darr Caterpillar - Davis Technologies - Delta International - Devon - D. J. Plastics - Eaton Leonard - EBTEC - Electro-Motive - Emergency One - Eureka - Foster Mold - GeoDiamond/Smith International - Greenfield Industries - Hunter Douglas - Industrial Laser - ITT Engineered Valve - Kaiser Aluminum - Krueger International. - Laser Fare - Laser Services - Lockheed Martin - McDonnell Douglas - Mercury Tool - NASSCO - NutraSweet - Rapistan DEMAG - Reed Tool - ROHR, International - Searle - Solar Turbine - Southwest Fabricators - Smith & Wesson - Standard Refrigeration - Super Sagless - Taylor Guitars - Tecumseh - Teledyne Ryan - Thermal Ceramics - Thomas Lighting - FMC, United Defense - United Technologies Hamilton Standard

COLLEGE AFFILIATES

Aiken Technical College - Bevil Center for Advanced Manufacturing Technology - Central Florida Community College - Chicago Manufacturing Technology Extension Center - Great Lakes Manufacturing Technology Center - Indiana Vocational Technical College - Milwaukee Area Technical College - Okaloosa-Walton Community College - Piedmont Technical College - Pueblo Community College - Salt Lake Community College - Spokane Community College - Texas State Technical Colleges at Harlington, Marshall, Sweetwater

FEDERAL LABS

Jet Propulsion Lab - Lawrence Livermore National Laboratory - L.B.J. Space Center (NASA) - Los Alamos Laboratory - Oak Ridge National Laboratory - Sandia National Laboratory - Several National Institute of Standards and Technology Centers (NIST) - Tank Automotive Research and Development Center (TARDEC) - Wright Laboratories

SECONDARY SCHOOLS

Aiken Career Center - Chicopee Comprehensive High School - Community High School (Moraine, IL) - Connally ISD - Consolidated High School - Evans High - Greenwood Vocational School - Hoover Sr. High - Killeen ISD - LaVega ISD - Lincoln Sr. High - Marlin ISD - Midway ISD - Moraine Area Career Center - Morse Sr. High - Point Lamar Sr. High - Pontotoc Ridge Area Vocational Center - Putnam Vocational High School - San Diego Sr. High - Tupelo-Lee Vocational Center - Waco ISD - Westfield Vocational High School

ASSOCIATIONS

American Vocational Association (AVA) - Center for Occupational Research and Development (CORD) - CIM in Higher Education (CIMHE) - Heart of Texas Tech-Prep - Midwest (Michigan) Manufacturing Technology Center (MMTC) - National Coalition For Advanced Manufacturing (NACFAM) - National Coalition of Advanced Technology Centers (NCATC) - National Skills Standards Pilot Programs - National Tooling and Machining Association (NTMA) - New York Manufacturing Extension Partnership (NYMEP) - Precision Metalforming Association (PMA) - Society of Manufacturing Engineers (SME) - Southeast Manufacturing Technology Center (SMTC)

MAST PROJECT EVALUATORS

Dr. James Hales, East Tennessee State University and William Ruxton, National Tooling and Machine Association (NTMA)

SPECIAL RECOGNITION

Dr. Hugh Rogers recognized the need for this project, developed the baseline concepts and methodology, and pulled together industrial and academic partners from across the nation into a solid consortium. Special thanks and singular congratulations go to Dr. Rogers for his extraordinary efforts in this endeavor.

This report is primarily based upon information provided by the above companies, schools and labs. We sincerely thank key personnel within these organizations for their commitment and dedication to this project. Including the national survey, more than 3,000 other companies and organizations participated in this project. We commend their efforts in our combined attempt to reach some common ground in precision manufacturing skills standards and curriculum development.

This material may be found on the Internet at **http://machinetool.tstc.edu**

CATALOG OF 15 VOLUMES

VOLUME 1	EXECUTIVE SUMMARY STATEMENT OF THE PROBLEM MACHINE TOOL ADVANCED SKILLS TECHNOLOGY PROJECT PROJECT GOALS AND DELIVERABLES PROJECT METHODOLOGY PROJECT CONCLUSIONS AND RECOMMENDATIONS APPENDICES
VOLUME 2	CAREER DEVELOPMENT GENERAL EDUCATION REMEDIATION
VOLUME 3	MACHINING - CORE COURSES (MAC)
VOLUME 4	MANUFACTURING ENGINEERING TECHNOLOGY (MET)
VOLUME 5	MOLD MAKING (MLD)
VOLUME 6	WELDING (WLD)
VOLUME 7	INDUSTRIAL MAINTENANCE (IMM)
VOLUME 8	SHEET METAL (SML) AND COMPOSITES (COM)
VOLUME 9	TOOL AND DIE (TLD)
VOLUME 10	COMPUTER-AIDED DRAFTING AND DESIGN (CAD)
VOLUME 11	COMPUTER-AIDED MANUFACTURING AND ADVANCED CNC (CNC)
VOLUME 12	INSTRUMENTATION (INT)
VOLUME 13	LASER MACHINING (LSR)
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VOLUME 6
WELDING TECHNOLOGY

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FOREWORD

Under the pressure of changing consumer demands, global competition, and increasingly exacting product and inventory control requirements, United States manufacturing has entered an era of automation and technological sophistication with the inevitable impact of loss of blue collar and mid-level management jobs and assignment of more responsibility to technical employees. The result is a growing surplus of workers whose jobs are now obsolete, and a growing demand for workers whose skills and knowledge straddle the once distinct areas of manufacturing, engineering, programming, and design. Workers who wish to remain employable in the manufacturing sector cannot rely on traditional skills for their economic survival. Upgrading of skills or acquisition of a variety of skills is crucial.

The employment picture for the Welder exemplifies this trend. Welding is a traditional manufacturing skill which stills exists in its traditional forms - hand welding, stick welding, tungsten inert gas machine, metal inert gas machine, Bronco guns, and cutting by plasma cutters - in the contemporary manufacturing workplace. However, recent advances in technology have caused the emergence of new manufacturing welding processes. The contemporary welder must be able to use automatic welding machines, precision hand-held measuring devices, and automated cutting processes to produce finished products that meet the precision and exactness demands of the global marketplace. Existing welders who wish to remain employed or those who wish to enter the field must be willing and able to obtain training in all aspects of emerging welding technology.

Recognizing the need to increase the supply of new skilled workers in this and other occupations for the metal and metals-related industries, the U.S. Department of Education launched the Cooperative Demonstration Program (Manufacturing Technologies) as part of the National Skills Standards Act of 1994. The goal of the Department initiative was to foster the development and implementation of national skill standards and a training model for certificate and Associate of Science degree programs. In July 1994, a multi-state consortium of community colleges led by Texas State Technical College received a grant awarded by the Department under the initiative. The Machine Tool Advanced Skills Technology (MAST) consortium, which includes six of the nation's leading Advanced Technology Centers (ATCs), was formed to develop, test, and disseminate industry-specific skill standards and model curricula for the U.S. machine tool industry over a two year period. As part of the MAST consortium, Moraine Valley Community College in Illinois was tasked with developing and piloting skill standards and model curricula in the technical area of Welder.

After numerous interviews with practitioners from industry (see Appendix A) and discussions with educators, managers, supervisors, and others involved with machine related occupations and specifically welding technology, the MAST consortium partners have agreed to present our definition of a Welder as follows:

WELDER: *The Welder will be able to use arc/gas, shielded metal arc welding, gas metal arc welding, gas tungsten arc welding, brazing, metallurgy, and print interpretation to perform welding operations necessary to produce a workpiece to required standards.*

Moraine Valley Community College's curricula for welding technology is structured as a 26 course, one year certificate course of study. Course options can be tailored to individual student needs.

This volume contains the justification, documentation, and course syllabi for the courses recommended as minimum training for individuals desiring to become welders.

PARTNER OCCUPATIONAL SPECIALITY ASSIGNMENTS

Although each of the six partner college development centers possessed detailed expertise in each of the MAST 15 occupational specialities, a division of work was still very necessary to ensure completion of the project due to the enormity associated with industrial assessment and complete curriculum revision for each of the areas of investigation.

Each Collegiate Partner was responsible for development of a specialization component of the overall model. Information for the future direction of this specialization area was obtained from NIST Manufacturing Centers and/or national consortia, professional societies, and industrial support groups addressing national manufacturing needs. Each Collegiate Partner tested its specialization model utilizing local campus resources and local industry. Information gained from the local experience was utilized to make model corrections. After testing and modification, components were consolidated into a national model. These events occurred during the first year of the Program. During the second year of the Program, the national model was piloted at each of the Collegiate Partner institutions. Experience gained from the individual pilot programs was consolidated into the final national model.

What follows is a profile of the MAST development center which had primary responsibility for the compilation and preparation of the materials for this occupational specialty area. This college also had the responsibility for conducting the pilot program which was used as one of the means of validation for this program.

MAST DEVELOPMENT CENTER, PALOS HILLS, IL
Moraine Valley Community College
Center for Contemporary Technology

Dr. Vernon O. Crawley, President
Moraine Valley Community College
Dr. Richard Hinckley
Dean, Business and Industrial Technology
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Manufacturing in Moraine Valley

The metropolitan Chicago area, including northwestern Indiana, is among the most heavily industrialized areas of the United States. The neighboring Moraine Valley area is home to hundreds of the small- to medium-sized companies that supply the larger industrial concerns, including design, fabrication, metal-working and parts-assembly firms. The diversity of industry in the region and the continual need for qualified entry-level technicians and retraining of current workers has created a great demand for the development of industrial training and the services of Moraine Valley Community College and its Center for Contemporary Technology.

Moraine Valley Community College (MVCC) and the Center for Contemporary Technology (CTT)

Moraine Valley Community College (MVCC) is a public, postsecondary institution serving all or part of 26 communities in the southwest suburban area of Cook County, representing a population of more than 380,000. Located 25 miles southwest of downtown Chicago in Palos Hills, the college is the fourth largest community college in Illinois and serves a diverse student body drawn from the surrounding communities. The focal point for business and industry training in Moraine Valley is the 124,000 s.f. Center for Contemporary Technology (CTT). Opened in 1988, the Center is among the finest and most diverse advanced technology centers (ATC's) in the nation, with over $6 million of equipment and technology to provide training and education in Automated Manufacturing; Automotive Technology; Computer-Aided Design; Corrosion Mitigation; Electronics/Telecommunications; Environmental Control Technology; Information Management; Machining; Mechanical & Fluid Power Maintenance; Non-Destructive Evaluation; and Welding.

Development Team

- **Project Director**: Richard Hinckley, PhD., Dean of Instruction for Business and Industrial Technology and manager of the Center for Contemporary Technology, served as director for the MAST project.
- **Subject Matter Expert**: Charles H. Bales, Instructor of Mechanical Design/Drafting, had program responsibility for developing skill standards and course/program materials for the mechanical design/drafting component of the MAST project. Professor Bales also served as lead instructor for the MAST pilot program in Computer-Aided Drafting and Design (CADD) Technician.
- **Subject Matter Expert**: James E. Greer, MS Ed., Professor of Welding, was responsible for developing skill standards and course/program materials for the welding component of the MAST project. Professor Greer also served as lead instructor for the MAST pilot program in Welding.
- **Skills Validation Coordinator**: Richard Kukac, MPA, Associate Dean of Instruction of Business and Industrial Technology, coordinated the industry skills verification process for MAST and facilitated the industry validation sessions with teams of expert practitioners from each skill area.

THE MAST COMPETENCY PROFILE

Development of Competency Profiles at each of the MAST sites began with visits to representative companies for the purpose of surveying expert workers within the industry and occupational areas under investigation. Each site began the survey process by asking a subject matter expert in the targeted technical area, generally a member of their faculty, to employ a modified version of the generally-accepted DACUM (Developing A Curriculum) method to categorize the major skills needed to work in the selected occupation. As source materials, the college instructors drew on their professional knowledge and experience of current and future industry requirements. The initial skill standards developed by the subject matter experts underwent numerous internal reviews and revisions within each site, assuming final form as a series of structured survey and interview statements designed to elicit a simple yes or no response.

To determine an appropriate survey sample, each site compiled a database of their region's small and medium-sized manufacturers and searched for companies likely to employ workers in the targeted occupational area. The resulting cross-industry samples were sorted further to achieve a balance of technological capability and workforce size; the sample companies within each region were then asked to participate in the project. Willing respondents were scheduled for interviews.

During the company interviews, MAST staff asked expert workers to identify the primary duties and tasks performed by a typical worker and to consider the special skills and knowledge, traits and attitudes, and industry trends that will have an impact on worker training, employability, and performance both now and in the future. The interview results were analyzed to create individual profiles identifying the most common duties and skills required of workers at each company. Copies of individual company competency profiles are provided in Appendix A of this volume. These individual company Competency Profiles served two purposes. First, they showed, in a format that could be easily understood by both industry and educators, a picture of the occupational specialty at a given company at that particular time. Second, these individual company Competency Profiles furnished the company with a document for which they could claim ownership. This, in effect, made them "real" partners in the work of MAST.

Data for all companies were then aggregated to develop a composite Competency Profile of industry skill standards within the selected occupational specialty area of, as shown in the following pages.

These same duties and tasks were then included in both the Texas and National Surveys for further validation (see Volume 1). As a result of the surveys, additional refinements were made to the Competency Profiles. These changes were then incorporated into the individual course syllabi which were used for the pilot program.

The MAST Competency Profile for this occupational specialty area has been included on the following pages.

SKILLS AND KNOWLEDGE

Communication Skills
Use Measurement Tools
Use Inspection Devices
Mathematical Skills
Reading/Writing Skills
Knowledge of Safety Regulations
Practice Safety in the Workplace
Organizational Skills
Knowledge of Company Policies/Procedures
Mechanical Aptitude
Ability to Comprehend Written/Verbal Instructions
Knowledge of Cutting Fluids/Lubricants
Basic Knowledge of Fasteners
Ability to Work as Part of a Team
Converse in the Technical Language of the Trade
Knowledge of Occupational Opportunities
Knowledge of Employee/Employer Responsibilities
Knowledge of Company Quality Assurance Activities
Practice Quality-Consciousness in Performance of the Job

MORAINE VALLEY COMMUNITY COLLEGE
MAST PROGRAM REPRESENTATIVES

DR. RICHARD C. HINCKLEY

RICHARD KUKAC
Site Coordinator

Moraine Valley Community College

TRAITS AND ATTITUDES

Strong Work Ethic
Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Conscientious
Motivation
Responsible
Physical Ability
Professional
Trustworthy
Customer Relations
Personal Ethics

TOOLS AND EQUIPMENT

Machinist's Tools (e.g., calipers, dial indicators, magnetic tool holders, etc.)
Measuring Tools
Power Tools
Metal Lathe with Attachments
Drill Presses
Vertical Mill with Attachments
Power Saws
Power Drills
Hydraulic/Arbor Press
Heat Treatment Equipment
Hardness Testing Equipment
Grinding Machines with Attachments
Welding Equipment (SMAW, GMAW, FCAW)
CNC Machining Center and Turning Center
Gear Producing Machines with Attachments
Alignment/Calibration Tools
Coolant Recovery Equipment
Computer
Ventilation Equipment
Forklift
Personal Safety Equipment
Oxyacetylene Equipment
Tool Storage Equipment
Workbenches
Vises
Pedestal Grinders
Weld Test Equipment
Optical Comparator
Coordinate Measurement Machine

CURRENT TRENDS/CONCERNS

Statistical Process Control
Composites
Laser Machining
Advanced Computer Applications
Robotics
Environmental Concerns
Fiber Optic Controls
Automated Material Handling Equipment
Computer Integrated Manufacturing

COMPETENCY PROFILE
Welder

Conducted By
M.A.S.T.
Machine Tool Advanced Skills
Technology Program
and
Consortium Partners
(V.199J40008)

***M*achine Tool *A*dvanced *S*kills**
***T*echnology Program**

MAST

Welder... and study arc/gas, SMAW, GMAW, GTAW, brazing, metallurgy, and print interpreation to perform welding operations necessary to produce a workpiece to required standards and/or specifications.

Duties ← **Tasks** →

A	Follow Safe Practices	A-1 Wear personal protective equipment	A-2 Identify safety rules	A-3 Familiarize safety at facility									
B	Demonstrate Technical Communication	B-1 Use standard American Welding Standard Society welding terms and definitions											
C	Interpret Welding Drawings	C-1 Review print notes, dimensions and symbols	C-2 Identify basic layout of drawings	C-3 Interpret drawing lines and views	C-4 Interpret welding symbols	C-5 Convert Metric to English	C-6 Understand print specifications	C-7 List assembly procedure per print	C-8 Understand various types of welding prints	C-9 Visualize final weldment from print	C-10 List flaws and errors on drawings	C-11 Interpret AWS standard welding symbols	
D	Basic Welding Metallurgy	D-1 Become conversant with common metallurgical terms	D-2 Describe the properties of various types of steel	D-3 List various alloys and their effect when combined with steel	D-4 Describe the effect welding has on properties of various types of carbon steels	D-5 Identify basic concepts relating to the heat affected zone							
E	Basic Shielded Metal Arc Welding (SMAW) and Oxy-Fuel Gas Cutting	E-1 Define selected welding terms per AWS A3.0	E-2 Describe AWS code for mild steel electrodes	E-3 Set up welding machine to required polarity	E-4 Use correct start and stop techniques for SMAW electrodes	E-5 Set up equipment for Shielded Metal Arc Welding	E-6 Strike an arc, run continuous stringer bead	E-7 Weld using weave technique	E-8 Weld multi-layer buildup	E-9 Set up and shut down oxy-fuel equipment	E-10 Cut steel plate using oxy-fuel equipment	E-11 Produce welds with properly fused starts and filled craters	E-12 Low hydrogen starts and stops	E-13 Design welded joints
		E-14 Weld V groove with backing in flat position	E-15 Set up air carbon arc equipment for gouging	E-16 Use air carbon arc to excavate a partial pen groove weld	E-17 Gouge to excavate defect	E-18 Make x-ray quality weld repair on a 2F position T joint 1/2" plate	E-19 Produce fillet weld on sheet steel T joints	E-20 Produce fillet welds on T joints made up to both thick and thin joint members using SMAW	E-21 Use correct starts for low hydrogen electrodes	E-22 Use correct stops for low hydrogen electrodes	E-23 Weld using large diameter SMA electrodes			
F	Advanced Shielded Metal Arc Welding (SMAW) and Cutting	F-1 Weld single V groove welds with open roots from one side	F-2 Weld various diameters of pipe to plate	F-3 Produce SMAW pipe - 5G position	F-4 Produce SMAW - 2G position groove welds	F-5 Roll weld pipe - SMAW	F-6 Produce SMAW pipe - 6G position	F-7 Create SMAW pipe to ASME Section 9	F-8 Interpret welding procedures					
G	Pipe Welding - SMAW	G-1 Produce end preparations	G-2 Fit and tack weld pipe	G-3 Roll weld open root pass on pipe - 1G position	G-4 Weld open root pipe joint - 2G position	G-5 Weld open root pipe - 5G position	G-6 Pass guided bend tests per ASME Section 9	G-7 Weld open root pipe - 2G position	G-8 Weld pipe open root passes all positions using GMAW	G-9 Weld pipe with backing using FCAW-G				
H	Gas Metal Arc Welding (GMAW)	H-1 Assemble GMAW gun and name all parts	H-2 Understand gas metal arc power source	H-3 Shielding gas application	H-4 Weld with GMAW using spray transfer	H-5 Weld with GMAW using short circuit transfer	H-6 Weld with GMAW using globular transfer	H-7 Weld with GMAW using pulsed spray transfer	H-8 Weld T joints on carbon steel using GMAW equipment	H-9 Weld multi-pass fillet welds - all positions	H-10 Weld multi-pass fillet welds - 3F vertical position	H-11 Weld multi-pass fillet welds - 4F overhead position	H-12 Weld single V groove with GMAW	H-13 Weld pipe - 1G position
I	Gas Tungsten Arc Welding (GTAW)	I-1 Understand technical aspects of GTAW	I-2 Weld fillet - 2F horizontal position	I-3 Weld fillet - 3F vertical position	H-4 Weld fillet - 4F overhead position	I-5 Weld on 1/8" material and 100% penetration	I-6 Weld 2G position using GTAW	I-7 Weld 3G position using GTAW	I-8 Weld 4G position using GTAW	I-9 Weld pipe open root passes all positions using GTAW				

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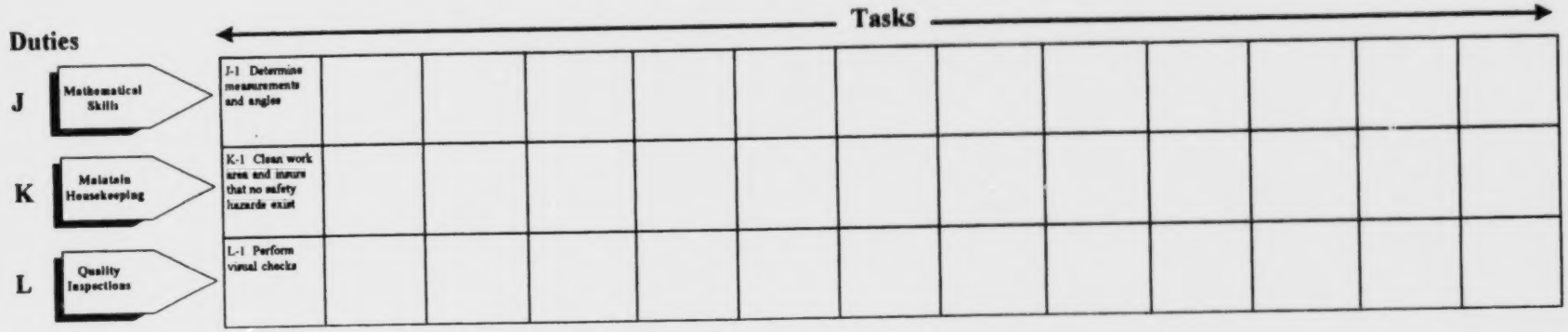
Tasks
Duties
J
Mathematical Skills
K
Maintain Housekeeping
L
Quality Inspections
J-1 Determine measurements and angles
K-1 Clean work area and insure that no safety hazards exist
L-1 Perform visual checks

THE MAST TECHNICAL WORKPLACE COMPETENCY OUTLINE

The Competency Profiles derived from the industry survey process were returned to industry and faculty members at each MAST partner college for review. Reviewers were asked to identify specific sub-tasks within each block of Duties and Tasks in the Profile; MAST staff at each college broke the sub-tasks down further into the detailed steps required to actually perform the duties and tasks of the manufacturing process. It is these detailed skill standards that were then incorporated into development of the curriculum and piloted as a training program by each of the MAST colleges. All results for the specific occupational specialty area have been organized as an outline of the duties, tasks, and sub-tasks required to demonstrate technical competency in the workplace, as shown in the following pages.

As a result of the Texas and the National Surveys, additional refinements were made to the Competency Outlines. These changes were then incorporated into the individual course syllabi.

The MAST Technical Workplace Competency Outline for this occupational specialty area has been included on the following pages.

WELDER
TECHNICAL WORKPLACE COMPETENCIES

WELDER...*and study arc/gas, SMAW, GMAW, GTAW, brazing, metallurgy, and print interpretation to perform welding operations necessary to produce a workpiece to required standards.*

A. FOLLOW SAFE PRACTICES

1. Wear Personal Protective Equipment
   - a. List personal protective equipment for shielded metal arc welding
   - b. List personal protective equipment for gas tungsten arc welding
   - c. List personal protective equipment for gas metal arc welding
   - d. List personal protective equipment for flux cored arc welding
   - e. List personal protective equipment for submerged arc welding
   - f. List personal protective equipment for oxy-fuel cutting
   - g. List personal protective equipment for plasma arc cutting
   - h. List personal protective equipment for air carbon arc gouging
   - i. During shop work, wear applicable personal protective equipment at all times
2. Identify Safety Rules
   - a. List environmental safety precautions i.e. fume control, radiation reflection, electrical consideration, fire hazards and control, etc.
   - b. List equipment safety rules, i.e., ventilation, grounding, duty cycle
   - c. Utilize safety when handling and storing compressed gas cylinders
   - d. List general shop safety rules
   - e. Maintain safe conditions in workstation. Student demonstrate by setting up safe workstation.
   - f. Comply with confined space entry safety procedures
   - g. Conduct a safety inspection of the student work area
   - h. Conduct a safety inspection of the welding shop
   - i. Conduct a safety inspection of the gas storage area
3. Familiarize Oneself With Safety at Facility
   - a. Attend safety tour of welding lab
   - b. Receive a safety orientation lecture
   - c. Avoid fumes through proper ventilation and good practices
   - d. Operate exhaust system
   - e. Practice electric safety with respect to welding
   - f. Protection from radiation with an understanding of personal safety equipment and conduct
   - g. Demonstrate a knowledge of fire prevention and protection for welding in dress and conduct
   - h. List welding and cutting safety rules
   - i. Demonstrate oxy-fuel gas cutting safety
   - j. Demonstrate arc welding safety

B. DEMONSTRATE TECHNICAL COMMUNICATION

1. Use Standard American Welding Standard Society Welding Terms and Definitions
   - a. Follow verbal instructions

b. Follow written details
c. Prepare time and job cards (reports & records)

C. INTERPRET WELDING DRAWINGS

1. Review Print Notes, Dimensions and Symbols
   a. Interpret AWS standard welding symbols
   b. List essential components found in general notes on drawing
   c. Determine acceptable tolerances for drawing
   d. Determine code requirements, process and procedure requirements required by drawing
   e. Interpret 3 view drawings
   f. Work from drawings, prints and sketches
2. Identify Basic Layouts of Drawings
3. Interpret Drawing Lines and Views
4. Interpret Welding Symbols
5. Convert Metric to English
6. Understand Print Specifications
7. List Assembly Procedure Per Print
8. Understand Various Types of Welding Prints
9. Visualize Final Weldment From Print
10. List Flaws and Errors on Drawings
11. Interpret AWS Standard Welding Symbols

D. BASIC WELDING METALLURGY

1. Become Conversant With Common Metallurgical Terms
   a. Describe structure of metals
   b. Describe critical temperature
   c. Define allotropic transformation
   d. Describe eutectic point
   e. Read phase diagram
   f. Define liquidus
   g. Define solidus
   h. Define annealing
   i. Define normalize
   j. Define heat treatment
   k. Define stress relieve
   l. Define delta ferrite
   m. Define ferrite
   n. Define austenite
   o. Define pearlite
   p. Define cementite
   q. Define tempering
2. Describe the Properties of Various Types of Steel
   a. Define low carbon steel
   b. Define medium carbon steel
   c. Define high carbon steel
   d. Define very high carbon steel
   e. Define cast iron

K. MAINTAIN HOUSEKEEPING

1. Clean Work Area and Insure That No Safety Hazards Exist
    a. Sweep table top and floor in work area
    b. Clean equipment and tools
    c. Return tools to proper storage area
    d. Dispose of waste materials and scrap in their proper receptacle containers and storage areas
    e. Store all unused materials to their respective storage areas

L. QUALITY INSPECTIONS

1. Perform Visual Checks
    a. Identify common welding defects
    b. List terms for common welding defects
    c. Rate common welding defects in order of severity
    d. Name size of limitations for defects given under various codes

f. Define low alloy high strength
g. Define alloy steels
h. Define stainless steels
i. Define non ferrous metals

3. List Various Alloys and Their Effect When Combined With Steel
   a. Draw and describe substitutional alloys
   b. Draw and describe interstitial alloys
   c. Draw and describe multi phase alloys
   d. Define harden ability
   e. Work carbon equivalent equations
4. Describe the Effect Welding Has on Properties of various Types of Carbon Steels
   a. Sketch crystal structures of metals
   b. Sketch face centered cubic
   c. Sketch body centered cubic
   d. Sketch hexagonal close packed
5. Identify Basic Concepts Relating to the Heat Affected Zone
   a. Define micro structure
   b. Define macro structure
   c. Define cold working
   d. Define elongated grain structure
   e. Define grain boundary
   f. Define grain growth
   g. Define fusion zone
   h. Define fusion interface

E. BASIC SHIELDED METAL ARC WELDING (SMAW) AND OXY-FUEL GAS CUTTING

1. Define Selected Welding Terms Per AWS A3.0
   a. Define arc welding process terms
   b. Define standard joint terminology
   c. Define common weld discontinuities
   d. Name welding equipment, supply and consumables
   e. Define common shop terms including proper equipment names
   f. Define material terms
   g. Define common metallurgy terms
2. Describe AWS Code for Mild Steel Electrodes
   a. List, describe and define
   b. List low hydrogen electrodes
   c. List iron powder electrodes
   d. Describe electrode by welding position
   e. Describe electrode by current and polarity
   f. Describe electrode by penetration
3. Set Up Welding Machine to Required Polarity
   a. List polarities for commonly used electrodes
   b. Describe both polarities
   c. Describe advantages and disadvantages of alternating current
4. Use Correct Start and Stop Techniques for SMAW Electrodes
   a. Describe and demonstrate start for non-low hydrogen SMAW electrode

b. Describe and demonstrate stop for non-low hydrogen SMAW electrodes with filled craters
c. List reasons for the importance of low hydrogen in weld metal
d. Explain the reason for low hydrogen starts and stops and how they work and why required specifically with E7018

5. Set Up Equipment for Shielded Metal Arc Welding
   a. Inspect area for safety
   b. Adjust current and polarity for specific job requirements
   c. Choose type and size of electrode
   d. Wear applicable personal safety equipment
6. Strike an Arc, Run Continuous Stringer Bead
   a. Stand and position oneself correctly
   b. Operate welding helmet
   c. Verbally warn others of intent to arc weld
   d. Strike an arc
   e. Weld with stringer bead technique
   f. Perform weld tie in's to make continuous bead
7. Weld Using Weave Technique
   a. Maintain required weld quality
   b. Maintain proper weld width uniformly
   c. Maintain proper travel speed
   d. Match correct oscillation for various electrodes
   e. Match applications to weave techniques, as they apply
   f. List the advantages and disadvantages of weave techniques
   g. List the advantages and disadvantages of stringer techniques
   h. Perform weld using weave technique
   i. Concentrate on dwell times at edges of weld pool
8. Weld Multi-Layer Buildup
   a. Weld a dam to outline area being welded for each layer
   b. Apply each layer neatly, straight and with good fusion throughout
   c. Chip slag after each pass
   d. Weld passes which over lap to crown of last weld bead
   e. Demonstrate control of bead height
9. Set Up and Shut Down Oxy-Fuel Equipment
   a. Follow manufacturer's recommended practice
   b. Inspect equipment and work area for safety
   c. Assemble oxy-fuel equipment
   d. Open fuel gas cylinder ½ turn
   e. Open oxygen as cylinder all the way
   f. Adjust fuel gas and oxygen working pressure per manufacturer's recommendation
   g. Purge lines one at a time. One second for each 10 feet of hose length
10. Cut Steel Plate Using Oxy-Fuel Equipment
    a. Make manual free hand straight line cuts
    b. Cut manually straight lines using cutting jib
    c. Bevel plate with manual oxy-fuel equipment
    d. Manually cut blind holes in thick material
    e. Manually cut sheet metal with minimal distortion

11. Produce Welds with Properly Fused Starts and Filled Craters
    a. Use non-low hydrogen electrodes
    b. Strike arc and hold long arc length 1" away from last weld crater
    c. Back-up to previous weld crater holding long arc length
    d. Pre-heat crater with long arc
    e. Shorten arc length, fill crater and continue welding
12. Low Hydrogen Starts and Stops
    a. Use low hydrogen electrodes
    b. Strike arc 1" from crater
    c. Immediately shorten arc length and back up quickly previous weld crater. Holding short arc length
    d. Pause at the crater when it is filled. Continue welding
13. Design Welded Joints
    a. List the names and draw side views of the five basic joint configurations
    b. List the names and draw side views of the variations of grooves
    c. List the names and draw side views of the T-Joint variations
    d. List the name of the type of weld made in each joint
14. Weld V Groove With Backing in Flat Position
    a. Use oxy-fuel equipment to bevel 3/8" steel to 37 1/2°
    b. Clean bevel face with grinder as required
    c. Cut 1/4" material for backing strip
15. Set Up Air Carbon Arc Equipment for Gouging
    a. List the minimum rated amperage and duty cycle for a welding machine used for air carbon arc gouging according to lecture
    b. List minimum flow rate and pressure for an air compressor used in air carbon arc cutting and gouging
    c. List the polarity that air carbon arc is run on
    d. Describe approximate amperage settings for 1/8", 3/16", 1/4" and 3/8" carbon electrodes
    e. Connect air carbon torch arc and compressed air hose to welding machine
    f. Inspect area for safety
16. Use Air Carbon Arc to Excavate a Partial Pen Groove Weld
    a. Locate root of weld
    b. Demonstrate control of depth of cut
    c. Demonstrate control of width of cut
    d. Use air carbon arc cutting equipment to make shallow gouges (about 1/8" deep max.) with stringer technique
    e. Make gouges of uniform depth
    f. Observe discontinuities as gouging proceeds
    g. Gouge until some weld metal is reached
17. Gouge to Excavate Defect
    a. Given the area of suspected discontinuity its size and depth; air carbon 1 gouge using multi pass and stringer gouge to defect depth
    b. Measure to make sure excavation is at proper location and depth
    c. Use air carbon arc equipment. Shape excavation to ensure proper fusion
    d. Clean area of all scale, carbon etc.
18. Make X-Ray Quality Weld Repair on a 2F Position T Joint ½" Plate

a. Check area for safety
b. Set SMAW equipment current and polarity for 1/8" E7018
c. Attach work lead
d. Preheat and maintain interpass temperature as required
e. Weld first pass paying special attention to low hydrogen techniques
f. Grind the weld start and stop to remove cold lap and lack of fusion
g. Weld the second pass starting from opposite end
h. Repeat starts and stops until weld is completed
i. Inspect and submit for non-destructive testing RT or UT

19. Produce Fillet Weld on Sheet Steel T Joints
    a. Check work area for safety
    b. Position steel in a T joint and tack at ends
    c. Place T joint in the 2F position with a spacer on each end so the workpiece is not touching the work bench. This stops any heat sink.
    d. Produce fillet welds equal in size to the thickness of the smallest joint member. With SMAW E6011, E6013 and GMAW and GTAW
    e. Visually inspect to AWS D1.3
20. Produce Fillet Welds on T Joints Made Up of Both Thick and Thin Joint Members Using SMAW
    a. Inspect work area for safety
    b. Set SMAW equipment for type and size of electrode and job requirements
    c. Fit up and tack joint
    d. Weld joint keeping the major portion of heat on thicker section
    e. Clean and visually inspect
21. Use Correct Starts for Low Hydrogen Electrodes
    a. List the AWS steel electrode code last digit designation for low hydrogen electrode
    b. Set up SMAW e.g. and check for safety
    c. Using E7018 strike an arc 1" down the path of welding from where you wish to start
    d. Shorten arc length immediately to low hydrogen arc length
    e. Quickly approximate 3 times as fast as welding travel speed back up the one inch to the point at which the weld should start
    f. Stop movement at starting point and allow weld pool to form
    g. Begin normal travel speed once weld pool reaches required diameter
22. Use Correct Stops for Low Hydrogen Electrodes
    a. Use E7018 to begin weld correctly
    b. Stop increase weld travel speed
    c. Observe weld pool when weld pool size decreases to smallest possible size, break off arc by pulling away
23. Weld Using Large Diameter SMA Electrodes
    a. Set up SMAW equipment for use with 3/16" and E7018
    b. Tack up a T joint using ½" steel
    c. Set amperage from 180 to 200 DC amps
    d. Begin the weld with a low hydrogen start by using a 75° lead angle (To fight arc blow)
    e. Bring lead angle back to normal as the weld progresses 2" along joint

f. Begin changing the lead angle to a push or forehand angle of 70° to 80° 3" from the end of joint
g. Make multi-pass fillet welds with smooth contour
h. Visually inspect to insure

F. ADVANCED SHIELDED METAL ARC WELDING (SMAW) AND CUTTING

1. Weld Single V Groove Welds With Open Roots From One Side
   a. Bevel 3/8" steel plate to 37 1/2° using oxy-fuel gas cutting eg.
   b. Use grinder to remove oxide larger and smooth plate
   c. Use grinder to create root face of 3/32" to 1/8"
   d. Tack single V groove joint with 3/32" root opening
   e. Place joint in the 1G position
   f. Place joint in 2G position once task is mastered
   g. Place joint in 3G position once task is mastered
   h. Place joint in 4G position once task is mastered
   i. Weld the root with Direct Current Electrode Positive using 1/8" E6010. Use tight arc length and keyhole technique to produce a well fused root bead extending 1/16" above the plate.
   j. Weld chipped side slag and the root bead is wire brushed
   k. Fill the balance of the groove with 3/32", 1/8" and/or 5/32" E7018 using the stringer bead technique
   l. Visual test finished weld and root face bends evaluated to AWS D1.1 criteria
2. Weld Various Diameters of Pipe to Plate
   a. Inspect area for safety
   b. Place plate flat on welding table
   c. Place 3" pipe vertically on top of plate and tacked in place
   d. Leave weld coupon in the 2F fixed position
   e. Apply a 3/8" fillet weld using 1/8" E7018 and a stringer bead technique
   f. Visually inspect weld to AWS D1.1
   g. Fill pipe with water for 24 hours
   h. Check for leak
3. Produce SMAW Pipe - 5G Position
   a. Measure the pipe
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Tack the single V groove pipe joint with a 3/32" root opening
   g. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   h. Chip slag and wire brush weld
   i. Grind any lack of fusion and/or high spots
   j. Weld the balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
   k. Visually inspect weld on the root and face sides to ASME Section 9

l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

4. Produce SMAW - 2G Position Groove Welds
   a. Measure the pipe
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Tack the single V groove pipe joint with a 3/32" root opening
   g. Weld pipe joint
   h. Place the joint in the 2G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
   j. Weld balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
   k. Visually inspect weld on the root and face sides to ASME Section 9
   l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

5. Roll Weld Pipe - SMAW
   a. Measure the pipe
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Tack the single V groove pipe joint with a 3/32" root opening
   g. Roll weld pipe
   h. Place pipe coupon on workbench in the 1G roll welding position.
   i. Weld the root bead using 1/8" E6010 and the keyhole technique. The weld is performed in the 2:00 to 12:30 position
   j. Chip slag and wire brush. Grind any lack of fusion and/or high spots
   k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
   l. Visually inspect weld on the root and face sides to ASME Section 9
   m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

6. Produce SMAW Pipe - 5G Position
   a. Measure the pipe and
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"

f. Weld pipe
g. Tack the single V groove pipe joint with a 3/32" root opening
h. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique
i. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
j. Chip slag and wire brush. Grind any lack of fusion and/or high spots
k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
l. Visually inspect weld on the root and face sides to ASME Section 9
m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

7. Produce SMAW Pipe - 6G Position
   a. Measure the pipe
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Tack the single V groove pipe joint with a 3/32" root opening
   g. Place the joint in the 6G fixed position, using an 1/8" E6010 and a keyhole technique
   h. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
   j. Weld balance of groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
   k. Visually inspect weld on the root and face sides to ASME Section 9
   l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria
8. Create SMAW Pipe to ASME Section 9
   a. Bevel two pieces of pipe to 30° bevel angle using oxy-fuel gas cutting equipment
   b. Clean bevel face and a 3/32" root face is applied using a hand held grinder
   c. Set welding condition to weld open roots
   d. Tack pipe nipples together to form a V groove with a 1/8" root opening
   e. Place pipe in the 5G fixed position. The root pass is welded and cleaned by wire brushing
   f. Weld balance of the V groove with this procedure
   g. Visual inspection is made and evaluated by ASME Section 9
   h. Make four bend samples and evaluate by ASME Section 9
9. Interpret Welding Procedures
   a. Identify process
   b. Name joint design
   c. List base material

d. Give dimensions for root treatment
e. Name electrode size and type being used
f. List filler material (if required), classification and specification
g. Identify shielding gas - type and mixture
h. List pre and post heat and interpass temperature
i. Describe initial and interpass cleaning
j. Describe technique which is used
k. Produce single or multiple pass weld
l. Choose current type
m. Set current amperage
n. Set current polarity
o. Set voltage

G. PIPE WELDING - SMAW

1. Produce End Preparations
   a. Produce end preparations with oxy-fuel cutting
   b. Produce end preparations with plasma cutting
   c. Produce end preparations with mechanical cutting
   d. Produce end preparations with grinding
2. Fit and Tack Weld Pipe
   a. Cut and single bevel pipe to 37 1/2°
   b. Ground bevel face and touch up to within tolerances
   c. Check that pipe ends are square within given tolerances
   d. Prepare root face within given tolerances
   e. Align pipe to within given tolerances
   f. Set root opening to within given tolerances
   g. Tack pipe according to welding procedure specification - maintaining root opening
3. Roll Weld Open Root Pass on Pipe - 1G Position
   a. Fit up and tack pipe joint using 1/8" E6010 electrode, weld the root pass on pipe in the 1 o'clock to (2:00 o'clock position) according to procedure using the roll welding technique
   b. Weld remainder of pipe in the 1G roll welding position with E6010
   c. Weld the remaining portion of the groove using the weave technique using 5/32" E6010 electrode roll
4. Weld Open Root Pipe Joint - 2G Position
   a. Weld using 1/8" E6010
   b. Cut and grind pipe ends will be to single bevel edge preparations of 37 1/2°
   c. Fit together the two pipe ends to a single V edge preparation with given tolerances
   d. Weld root pass to ASME Section 9 requirements
   e. Fill balance of the groove with E6010 using the stringer technique to ASME Section 9 requirements
5. Weld Open Root Pipe - 5G Position
   a. Fit and tack weld pipe to within tolerances
   b. Place pipe in the 5G position
   c. Weld the rootpass using 1/8" E6010 to ASME Section 9 requirements
   d. Grind the finished root pass to remove high spots and any slag at weld toes

e. Weld the remainder of the groove using 3/32" and/or 1/8" E7018 using the stringer bead technique to ASME Section 9 requirements

6. Pass Guided Bond Tests Per ASME Section 9
   a. Remove bend samples from pipe at the 10, 2, 8 & 4 o'clock positions
   b. If the material is 3/8" or thinner 10 o'clock and 8 o'clock receive root bends and 2 o'clock and 4 o'clock receive face bends. If the pipe wall thickness is over 3/8" side bends shall be performed on all samples.
   c. Weld remainder of pipe in 1G position using E7018
   d. Perform low hydrogen starts and stops
   e. Weld using stringer bead technique
   f. Weld using weave technique
   g Chip slag wire brush and grind as necessary to assure clean weld deposits
7. Weld Open Root Pipe - 2G Position
   a. Use 1/8" E6010
   b. Cut and ground pipe ends to single bevel edge preparations of 37 1/2° c.Fit together two pipe ends to a single V edge preparation within given tolerances
   c. Weld root pass to ASME Section 9 requirements
   d. Clean weld pass by chipping slag, wire brushing and grinding where necessary to assure a clean, well fused weld deposit
   e. Weld remainder of the groove using E7018 with the stringer bead technique
8. Weld Pipe Open Root Passes All Positions Using GMAW
   a. Set up GMAW equipment
   b. Adjust wire feeder drive system
   c. Adjust shielding gas system and flow rate
   d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
   e. Set welding condition for short circuit transfer - Wire Feed Speed
   f. Set welding condition for short circuit transfer - Voltage
   g. Set welding condition for short circuit transfer - Tip to work Distance
   h. Weld root using a string bead technique
9. Weld Pipe With Backing Using FCAW-G
   a. Bevel pipe ends
   b. Touch up bevel face with grinder
   c. Fit and tack backing ring to one pipe end
   d. Fit other pipe over backing ring
   e. Adjust gap and tack in place
   f. Adjust shielding gas flow
   g. Adjust wire feed system
   h. Adjust power source to procedure specification
   i. Set wire feed speed to procedure specification
   j. Adjust voltage to procedure specification
   k. Adjust inductance to procedure specification
   l. Adjust GMAW gun for tip to work distance and shielding gas
   m. Weld according to procedure specification

H. GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts

a. Install adapter for particular brand of wire feeder
b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
c. Screw on gas defuser and tighten allen screw
d. Install contact tip
e. Install gas nozzle
f. Adjust gun for tip to work distance

2. Understand Gas Metal Arc Power Source
   a. Compare and contrast constant current and constant voltage power sources
   b. List effects of inductance on circuit
   c. List effects of pinch effect
3. Shielding Gas Application
   a. List arc characteristics caused by welding with 100% carbon dioxide
   b. List arc characteristics caused by welding with 100% argon
   c. List arc characteristics caused by welding with 75% Argon and 25% CO2
   d. List arc characteristics caused by welding with 95% Argon and 5% CO2
   e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness
7. Weld With GMAW Using Pulsed Spray Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
   a. Inspect area for safety

b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
c. Adjust the welding parameters for this task
d. Tack a T joint using GMAW
e. Weld 1/4" fillet welds in 2F position using string bead technique
f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"

9. Weld Multi-Pass Fillet Welds - All Positions
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Tack a T joint using GMAW
   e. Weld the second pass with electrode centered at the bottom toe of the first pass
   f. Weld the third pass with electrode centered at the top toe of the second pass
   g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique
   e. Weld the second pass with electrode centered at the bottom toe of the first pass
   f. Weld the third pass with electrode centered at the top toe of the second pass
   g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Place the T joint in the 4F overhead position approximately at eye level
   e. Weld a 1/4" fillet weld (wire brush weld after each pass)
   f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
12. Weld Single V Groove With GMAW
   a. Inspect the work area and equipment for safety
   b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
   c. Use grind to clean the bevel face and apply a 3/32" root face
   d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps

e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
f. Weld root upwards
g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
i. Complete the second pass using GMAW and upward Z weave technique
j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
k. Make fourth and final pass with the same technique.
l. The electrode is weaved from one bevel edge to another
m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges

13. Weld Pipe - 1G Position
a. Fit up and tack pipe according to given tolerances
b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

I. GAS TUNGSTEN ARC WELDING (GTAW)

1. Understand Technical Aspects of GTAW
a. List advantages and disadvantages of GTAW
b. List five applications where GTAW or PAW are better suited
c. List give applications which are more suited to SMAW than GTAW
d. Compare and contrast GTAW and plasma arc welding (PAC)
e. List by name the parts of a GTAW torch
f. Describe each control by name and function on the pulsed tig system such as a Lincoln square wave 350 or Miller syncrowave 351 P.
g. Assemble the GTAW torch, water cooler and GTAW machine

2. Weld Fillet - 2F Horizontal Position
a. Conduct safety inspection of the area and equipment
b. Weld on 304 stainless steel
c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
d. Cut stainless steel to .050" X 2" X 10"
e. Fit up and tack a T joint and place in the 2F position
f. Weld a .050" fillet weld using .045" ER308-L
g. Visually inspect joint for burn through, weld size and workmanship

3. Weld Fillet - 3F Vertical Position
   a. Conduct safety inspection of the area and equipment
   b. Weld on 304 stainless steel
   c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
   d. Cut stainless steel to .050" X 2" X 10"
   e. Fit up and tack a T joint and place in the 3F vertical position
   f. Weld a .050" fillet weld using .045" ER308-L
   g. Visually inspect joint for burn through, weld size and workmanship
4. Weld Fillet - 4F Overhead Position
   a. Conduct safety inspection of the area and equipment
   b. Weld on 304 stainless steel
   c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
   d. Cut stainless steel to .050" X 2" X 10"
   e. Fit up and tack a T joint and place in the 4F overhead position
   f. Weld a .050" fillet weld using .045" ER308-L
   g. Visually inspect joint for burn through, weld size and workmanship
5. Weld on 1/8" Material and 100% Penetration
   a. Conduct safety inspection of the area and equipment
   b. Weld on 304 stainless steel
   c. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
   d. Cut stainless steel and grind a .30" bevel on edges
   e. Place two pieces of stainless steel in the backing purge in the 1G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
   f. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
   g. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver.
6. Weld 2G Position Using GTAW
   a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
   b. Cut stainless steel and grind a .30" bevel on edges
   c. Place two pieces of stainless steel in the backing purge in the 2G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
   d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
   e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver

7. Weld 3G Position Using GTAW
   a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
   b. Cut stainless steel and grind a .30" bevel on edges
   c. Place two pieces of stainless steel in the backing purge in the 3G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
   d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
   e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver
8. Weld 4G Position Using GTAW
   a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
   b. Cut stainless steel and grind a .30" bevel on edges
   c. Place two pieces of stainless steel in the backing purge in the 4G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
   d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
   e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver.
9. Weld Pipe Open Root Passes All Positions Using GTAW
   a. Fit up and tack weld pipe to within procedure tolerances. (Set up GTAW equipment for welding carbon steel)
   b. Prepare tungsten for given procedure
   c. Set up GTAW torch for given procedure
   d. Set current for procedure
   e. Adjust shielding gas flow rate
   f. Weld root using free hand technique and using the walking the cup method
   g. Apply second pass using weave

J. MATHEMATICAL SKILLS

1. Determine Measurements and Angles
   a. Add fractions
   b. Subtract fractions
   c. Multiply fractions
   d. Divide fractions
   e. Change fractions to decimals
   f. Change decimals to fractions
   g. Solve simple algebraic equations
   h. Solve simple trigonometric equations
   i. Convert English measurement to Metric
   j. Convert Metric measurement to English

THE MAST PILOT PROGRAM CURRICULUM AND COURSE DESCRIPTIONS

After completing the Competency Profile and Technical Workplace Competency Outline for each occupational specialty area, each MAST partner reviewed their existing curricula against the industry-verified skill standards in order to identify a suitable foundation for new pilot training programs. Because each college had to comply with the requirements of its respective college system and appropriate state agency, the resulting pilot curricula for occupational specialty areas tended to vary in format and academic requirements (e.g., some programs were based on the semester system, others on the quarter system). Despite differences in the curricula developed at the partner colleges, each of the pilot programs was designed to achieve the following two goals mandated in the MAST grant proposal:

- Pilot Program: "Conduct a one year pilot program with 25 or more selected applicants at each college or advanced technology center to evaluate laboratory content and effectiveness, as measured by demonstrated competencies and indicators of each program area."

- Student Assessment: "Identify global skills competencies of program applicants both at point of entrance and point of exit for entry level and already-employed technicians."

(Note: All occupational specialty areas were not pilot tested at all Development Centers; however, all partner colleges conducted one or more pilot programs.)

Included on the following pages is the curriculum listing for the pilot program which was used to validate course syllabi for this occupational specialty area. This curriculum listing included course names and numbers from the college which conducted the pilot program. The curriculum also shows the number of hours assigned to each of the courses (lecture, lab and credit hours). Also included is a description of each of the courses.

WELDING TECHNOLOGY
ONE YEAR CERTIFICATE

First Semester		LEC	LAB	CR
WLD 111	Basic Arc/Gas Welding I	1	4	3
WLD 112	Basic Arc/Gas Welding II	1	4	3
WLD 104	Electrical Welding Circuits	2	0	2
WLD 105	Reading Welding Blueprints	3	0	3
		7	8	11
Second Semester				
WLD 121	Advanced SMAW and Cutting I	1	4	3
WLD 122	Advanced SMAW and Cutting II	1	4	3
WLD 123	MIG, TIG and Brazing I	1	4	3
WLD 124	MIG, TIG and Brazing II	1	4	3
WLD 113	Basic Welding Metallurgy	2	2	3
		6	18	15
Options				
WLD 137	Individual Welding Problems I	0	5	3
WLD 138	Individual Welding Problems II	0	5	3
WLD 140	Basic Pipe Welding I	1	4	3
WLD 141	Basic Pipe Welding II	1	4	3
WLD 160	Visual Inspection of Welds	3	0	3
		5	18	15
Option 1 =	**Program Totals**	13	36	32
WLD 137	Individual Welding Problems I			
WLD 138	Individual Welding Problems II			
Option 2 =	**Program Totals**	15	34	32
WLD 140	Basic Pipe Welding I			
WLD 141	Basic Pipe Welding II			
Option 3 =	**Program Totals**	16	31	32
WLD 137	Individual Welding Problems I			
WLD 160	Visual Inspection of Welds			

WELDING TECHNOLOGY
ONE YEAR CERTIFICATE
COURSE DESCRIPTIONS

WLD 111 **Basic Arc/Gas Welding I** (1-4-3) WLD 111 is the first half of the Basic Arc/Oxy-fuel Welding and Cutting course. The student will learn introductory skills in shielded metal, arc welding, oxy-acetylene welding and oxy-fuel cutting. The student will also learn safety procedures relating to these subjects and shop safety in general. This course will be taught using industrial procedures and guide lines. It features hands on welding instruction. Your participation is your key to success in this course.

WLD 112 **Basic Arc/Bas Welding II** (1-4-3) WLD 112 is the second half of the Basic Arc/Gas Welding and Cutting course. This hands-on class expands the students knowledge and experience in using various types of shielded metal arc welding electrodes in the flat and horizontal positions. The student will advance to welding single "V" groove welds in the 1G or flat position.

WLD 104 **Electrical Welding Circuits** (2-0-2) Theory and operation of the welding power source, welding circuits and welding equipment.

WLD 105 **Reading Welding Blueprints** (3-0-3) Introduction to blueprint reading for welding emphasizes basic interpretation of blueprints, welding symbols and basic sketching.

WLD 121 **Advanced SMAW and Cutting I** (1-4-3) In WLD 121 the student will practice SMAW in various positions. The student will gain proficiency in oxy-fuel cutting and air carbon arc cutting and gouging. The student will also study selected technical areas related to welding. Special emphasis will be placed on weld size and AWS code welding.

WLD 122 **Advanced SMAW and Cutting II** (1-4-3) In this nine week course, the student will advance his technique in out of position shielded metal arc welding. Welding of transitional joints and open groove welds will be stressed. Safety is our primary concern.

WLD 123 **MIG, TIG and Brazing I** (1-4-3) Welding, braze welding and brazing of various joints using GTAW, FMAW, FCAW, SAW and OFW.

WLD 124 **MIG, TIG and Brazing II** (1-4-3) Position welding brazing various joints using GTAW, GMAW, FCAW, SAW, and oxy/fuel.

WLD 113 **Basic Welding Metallurgy** (2-2-3) Students will earn about the physical and metallurgical properties of carbon steels and how welding will effect these properties.

WLD 137 **Individual Welding Problems I** (0-5-3) In this course the student will prepare a written proposal identifying specific problems to be addressed and submit it to the instructor for approval. Upon approval, this contract will state class meeting time and required written work. Students must make arrangements with instructor prior to signing up for class.

WLD 138 **Individual Welding Problems II** (0-5-3) In this course the student will prepare a written proposal identifying specific problems to be addressed and submit it to the instructor for approval. Upon approval, this contract will state class meeting time and required written work. Students must make arrangements with instructor prior to signing up for class.

WLD 140 **Basic Pipe Welding I** (1-4-3) Shielded Metal Arc Welding (SMAW) of pipe in the 2G & 5G positions. At the entry level of WLD 140, students are expected to pass AWS D1.1 qualification tests on ½" carbon steel plate in the 3G and 4G positions using SMAW.

WLD 141 **Basic Pipe Welding II** (1-4-3) Shielded Metal Arc Welding (SMAW) of pipe in the 6G positions. At the entry level of WLD 141, students are expected to pass AWS D1.1 qualification test on 6" schedule 40 carbon steel pipe in the 2G and 5G positions using SMAW.

WLD 160 **Visual Inspection of Welds** (3-0-3) Utilizing a combination of lecture, discussion, demonstration, and practical application the student will become familiar with the duties and responsibilities of the Welding Inspector and will be introduced to the various concepts and the general body of knowledge required for eventual certification as a Welding Inspector, as defined by AWS D1.1 and as realized by accomplishing the Specific Objectives of the course.

THE MAST TECHNICAL WORKPLACE COMPETENCY/COURSE CROSSWALK

Upon development of appropriate curricula for the pilot programs, each MAST college began to develop individual course outlines for its assigned specialty area. The skill standards identified in the Competency Profile were cross walked against the technical competencies of the courses in the pilot curriculum. The resulting matrix provided a valuable tool for assessing whether current course content was sufficient or needed to be modified to ensure mastery of entry level technical competencies. Exit proficiency levels for each of the technical competencies were further validated through industry wide surveys both in Texas and across the nation.

The Technical Workplace Competency/Course Crosswalk in the following pages presents the match between industry-identified duties and tasks and the pilot curriculum for . Course titles are shown in columns, duties and tasks in rows. The Exit Level Proficiency Scale, an ascending scale with 5 the highest level of proficiency, includes marked boxes indicating whether the task is covered by the instructor during the course; the numbers 1-5 indicate the degree of attention given to the task and the corresponding proficiency expected on the part of the student. The crosswalk is intended to serve as an aide to other instructional designers and faculty in community college programs across the nation.

Included on the following pages is the Technical Workplace Competency/Course Crosswalk for the pilot program curriculum. This crosswalk validates the fact that the duties and tasks which were identified by industry as being necessary for entry level employees have been incorporated into the development of the course syllabi.

Technical Workplace Competencies/Course

CROSSWALK

TECHNICAL COMPETENCY
WELDING TECHNOLOGY

	Basic Arc/Gas Welding I	Basic Arc/Gas Welding II	Electrical Welding Circuits	Reading Welding Blueprints	Advanced SMAW & Cutting I	Advanced SMAW & Cutting II	MIG, TIG and Brazing I	MIG, TIG and Brazing II	Basic Welding Metallurgy	Individual Welding Problems I	Individual Welding Problems II	Basic Pipe Welding I	Basic Pipe Welding II	Visual Inspection of Welds	EXIT LEVEL PROFICIENCY
A. FOLLOW SAFE PRACTICES															
A-1. Wear Personal Protective Equipment	X	X	X		X	X	X	X	X	X	X	X	X		3
A-2. Identify Safety Rules	X	X	X		X	X	X	X	X	X	X	X	X		3
A-3. Familiarize Oneself With Safety at Facility	X	X	X	X	X	X	X	X	X	X	X	X	X	X	2
B. DEMONSTRATE TECHNICAL COMMUNICATION															
B-1. Use Standard American Welding Standard Society Welding Terms and Definitions	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4
C. INTERPRET WELDING DRAWINGS															
C-1. Review Print Notes, Dimensions and Symbols				X											3
C-2. Identify Basic Layouts of Drawings				X											3
C-3. Interpret Drawing Lines and Views				X											3
C-4. Interpret Welding Symbols				X											3
C-5. Convert Metric to English				X											3
C-6. Understand Print Specifications				X											3
C-7. List Assembly Procedure Per Print				X											3
C-8. Understand Various Types of Welding Prints				X											3
C-9. Visualize Final Weldment From Print				X											3
C-10. List Flaws and Errors on Drawings				X											3
C-11. Interpret AWS Standard Welding Symbols				X											3
D. BASIC WELDING METALLURGY															
D-1 Become Conversant With Common Metallurgical Terms									X						4
D-2 Describe the Properties of Various Types of Steel									X						3
D-3 List Various Alloys and Their Effect When Combined With Steel									X						3
D-4 Describe the Effect Welding Has on Properties of Various Types of Carbon Steels									X						4
D-5 Identify Basic Concepts Relating to the Heat Affected Zone									X						3
E. BASIC SHIELDED METAL ARC WELDING (SMAW) AND OXY-FUEL GAS CUTTING															
E-1. Define Selected Welding Terms Per AWS A3.0	X	X	X		X	X	X	X		X	X	X	X		3
E-2. Describe AWS Code for Mild Steel Electrodes	X	X		X	X							X	X		4
E-3. Set Up Welding Machine to Required Polarity	X	X	X		X	X	X	X		X	X	X	X		4
E-4. Use Correct Start and Stop Techniques for SMAW Electrodes	X	X			X	X						X	X		4
E-5. Set Up Equipment for Shielded Metal Arc Welding	X	X			X	X						X	X		4

Technical Workplace Competencies/Course

CROSSWALK

TECHNICAL COMPETENCY
WELDING TECHNOLOGY

	Basic Arc/Gas Welding I	Basic Arc/Gas Welding II	Electrical Welding Circuits	Reading Welding Blueprints	Advanced SMAW & Cutting I	Advanced SMAW & Cutting II	MIG, TIG and Brazing I	MIG, TIG and Brazing II	Basic Welding Metallurgy	Individual Welding Problems I	Individual Welding Problems II	Basic Pipe Welding I	Basic Pipe Welding II	Visual Inspection of Welds	EXIT LEVEL PROFICIENCY
E-6. Strike an Arc, Run Continuous Stringer Bead	X	X			X	X						X	X		4
E-7. Weld Using Weave Technique	X	X			X	X						X	X		3
E-8. Weld Multi-Layer Buildup	X	X													3
E-9. Set Up and Shut Down Oxy-Fuel Equipment	X	X			X	X	X	X		X	X	X	X		4
E-10. Cut Steel Plate Using Oxy-Fuel Equipment	X	X			X	X	X	X		X	X	X	X		4
E-11. Produce Welds with Properly Fused Starts and Filled Craters	X	X			X	X	X	X		X	X	X	X		4
E-12. Low Hydrogen Starts and Stops		X			X	X						X	X		4
E-13. Design Welded Joints		X		X	X	X	X	X				X	X	X	4
E-14. Weld V Groove With Backing in Flat Position		X			X	X	X	X							4
E-15. Set Up Air Carbon Arc Equipment for Gouging		X	X		X	X	X	X				X	X		3
E-16. Use Air Carbon Arc to Excavate a Partial Pen Groove Weld		X			X	X	X	X							4
E-17. Gouge to Excavate Defect		X			X	X	X	X				X	X		2
E-18. Make X-Ray Quality Weld Repair on a 2F Position T Joint 1/2" Plate					X	X	X	X							4
E-19. Produce Fillet Weld on Sheet Steel T Joints		X			X										4
E-20. Produce Fillet Welds on T Joints Made Up of Both Thick and Thin Joint Members Using SMAW		X			X										3
E-21. Use Correct Starts for Low Hydrogen Electrodes		X			X	X						X	X		3
E-22. Use Correct Stops for Low Hydrogen Electrodes		X			X	X						X	X		3
E-23. Weld Using Large Diameter SMA Electrodes					X										2
F. ADVANCED SHIELDED METAL ARC WELDING (SMAW) AND CUTTING															
F-1. Weld Single V Groove Welds With Open Roots From One Side					X										3
F-2. Weld Various Diameters of Pipe to Plate					X										4
F-3. Produce SMAW Pipe - 5G Position										X					3
F-4. Produce SMAW - 2G Position Groove Welds										X					3
F-5. Roll Weld Pipe - SMAW										X					3
F-6. Produce SMAW Pipe - 5G Position										X					3
F-7. Produce SMAW Pipe - 6G Position											X				3
F-8. Create SMAW Pipe Weld to ASME Section 9											X				3
F-9. Interpret Welding Procedures					X		X			X	X				3
G. PIPE WELDING - SMAW										X	X				3
G-1. Produce End Preparations															

Technical Workplace Competencies/Course

CROSSWALK

TECHNICAL COMPETENCY
WELDING TECHNOLOGY

	Basic Arc/Gas Welding I	Basic Arc/Gas Welding II	Electrical Welding Circuits	Reading Welding Blueprints	Advanced SMAW & Cutting I	Advanced SMAW & Cutting II	MIG, TIG and Brazing I	MIG, TIG and Brazing II	Basic Welding Metallurgy	Individual Welding Problems I	Individual Welding Problems II	Basic Pipe Welding I	Basic Pipe Welding II	Visual Inspection of Welds	EXIT LEVEL PROFICIENCY
G-2. Fit and Tack Weld Pipe											X	X			3
G-3. Roll Weld Open Root Pass on Pipe - 1G Position											X				3
G-4. Weld Open Root Pipe Joint - 2G Position											X				3
G-5. Weld Open Root Pipe - 5G Position											X				3
G-6. Pass Guided Bond Tests Per ASME Section 9											X	X			2
G-7. Weld Open Root Pipe - 2G Position											X				3
G-8. Weld Pipe Open Root Passes All Positions Using GMAW								X							3
G-9. Weld Pipe With Backing Using FCAW-G								X							3
H. GAS METAL ARC WELDING (GMAW)															
H-1. Assemble GMAW Gun and Name All Parts							X	X							3
H-2. Understand Gas Metal Arc Power Source							X	X							3
H-3. Shielding Gas Application							X	X							2
H-4. Weld With GMAW Using Spray Transfer							X	X							3
H-5. Weld With GMAW Using Short Circuit Transfer							X	X							3
H-6. Weld With GMAW Using Globular Transfer							X	X							3
H-7. Weld With GMAW Using Pulsed Spray Transfer							X	X							3
H-8. Weld T Joints on Carbon Steel Using GMAW Equipment							X	X							3
H-9. Weld Multi-Pass Fillet Welds - All Positions							X	X							3
H-10. Weld Multi-Pass Fillet Welds - 3F Vertical Position							X	X							3
H-11. Weld Multi-Pass Fillet Welds - 4F Overhead Position							X	X							3
H-12. Weld Single V Groove With GMAW							X	X							3
H-13. Weld Pipe - 1G Position							X	X							2
I. GAS TUNGSTEN ARC WELDING (GTAW)															
I-1. Understand Technical Aspects of GTAW							X	X							3
I-2. Weld Fillet - 2F Horizontal Position							X	X							3
I-3. Weld Fillet - 3F Vertical Position							X	X							3
I-4. Weld Fillet - 4F Overhead Position							X	X							3
U-5. Weld on 1/8" Material and 100% Penetration							X	X							3
I-6. Weld 2G Position Using GTAW							X	X							3
I-7. Weld 3G Position Using GTAW							X	X							2

Technical Workplace Competencies/Course

CROSSWALK

TECHNICAL COMPETENCY
WELDING TECHNOLOGY

	Basic Arc/Gas Welding I	Basic Arc/Gas Welding II	Electrical Welding Circuits	Reading Welding Blueprints	Advanced SMAW & Cutting I	Advanced SMAW & Cutting II	MIG, TIG and Brazing I	MIG, TIG and Brazing II	Basic Welding Metallurgy	Individual Welding Problems I	Individual Welding Problems II	Basic Pipe Welding I	Basic Pipe Welding II	Visual Inspection of Welds	EXIT PROFICIENCY LEVEL
I-8. Weld 4G Position Using GTAW							X	X							2
I-9. Weld Pipe Open Root Passes All Positions Using GTAW							X	X							3
J. MATHEMATICAL SKILLS															
J-1. Determine Measurements and Angles				X											3
K. MAINTAIN HOUSEKEEPING															
K-1. Clean Work Area and Insure That No Safety Hazards Exist	X	X			X	X	X	X	X	X	X	X	X		3
L. QUALITY INSPECTIONS															
L-1. Visual Checks					X	X	X	X		X	X	X	X	X	2

WELDER
TECHNICAL WORKPLACE COMPETENCIES
EXIT LEVEL PROFICIENCY MATRIX

Welder: and study arc/gas, SMAW, GMAW, GTAW, brazing, metallurgy, and print interpretation to perform welding operations necessary to produce a workpiece to required standards.

The following matrix identifies the five exit levels of technical workplace competencies for the Welding Certificate at Moraine Valley Community College Illinois.

EXIT LEVEL OF PROFICIENCY					
Technical Workplace Competency	**1**	**2**	**3**	**4**	**5**
	rarely	routinely with supervision	routinely with limited supervision	routinely without supervision	initiates/ improves/ modifies and supervises others

THE MAST SCANS/COURSE CROSSWALK

The Secretary's Commission on Achieving Necessary Skills (SCANS), U. S. Department of Labor, has identified in its "AMERICA 2000 REPORT' the following five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance:

COMPETENCIES:

Resources:	Identifies, organizes, plans, and allocates resources
Interpersonal:	Works with others
Information:	Acquires and uses information
Systems:	Understands complex inter-relationships
Technology:	Works with a variety of technologies

FOUNDATION SKILLS:

Basic Skills:	Reads, writes, performs arithmetic and mathematical operations, listens and speaks
Thinking Skills:	Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons
Personal Qualities:	Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

Recognizing the value of SCANS proficiencies to job performance, as well as the growing mandate in many states to include SCANS activities in course curricula, MAST asked survey respondents to review the SCANS skill sets in the context of the draft skill standards for each occupational specialty area. MAST also incorporated evaluation of SCANS competencies and foundation skills into its assessment of the pilot training curricula. The results were summarized in a crosswalk that allowed MAST staff to modify course content where needed to strengthen achievement of SCANS competencies.

The following pages present the SCANS/Course Crosswalk for the pilot curriculum in Courses are listed along the top and SCANS competencies and foundations are shown along the left side of the matrix. An exit level proficiency matrix for SCANS competencies and foundation skills is provided as well.

As "soft" skills, the SCANS competencies are inherently difficult to quantify. MAST realizes that some faculty will emphasize the SCANS more or less than others. The SCANS/Course Crosswalk matrix has been included with this course documentation to show the importance of these "soft skills" and the importance of their being addressed in the classroom (particularly in technical classes). In time, faculty will learn to make these types of SCANS activities an integral and important part of the teaching process.

Included on the following pages is the SCANS/Course Crosswalk for the pilot program curriculum. This crosswalk validates the fact that the "soft skills" (SCANS) which were identified by industry as being necessary for entry level employees have been incorporated into the development of the course syllabi. Also included is a matrix which defines the exit level of proficiency scale (1-5).

SCANS/Course

CROSSWALK

WELDING TECHNOLOGY

	Basic Arc/Gas Welding I	Basic Arc/Gas Welding II	Electrical Welding Circuits	Reading Welding Blueprints	Advanced SMAW and Cutting I	Advanced SMAW and Cutting II	MIG, TIG and Brazing I	MIG, TIG and Brazing II	Basic Welding Metallurgy	Individual Welding Problems I	Individual Welding Problems II	Basic Pipe Welding I	Basic Pipe Welding II	Visual Inspection of Welds	EXIT PROFICIENCY LEVEL
(RE) RESOURCES:															
A. Allocates time	X	X		X	X	X	X	X		X	X	X	X		4
B. Allocates money												X	X		2
C. Allocates material and facility resources							X			X	X				2
D. Allocates human resources							X			X	X				2
(IN) INTERPERSONAL SKILLS:															
A. Participates as a member of a team	X	X		X	X	X	X	X		X	X	X	X		4
B. Teaches others	X	X		X	X	X	X	X		X	X	X	X		3
C. Serves clients/customers															
D. Exercises leadership	X	X	X	X	X	X	X	X	X	X	X	X	X	X	6
E. Negotiates	X	X	X	X	X	X	X	X	X	X	X	X	X	X	3
(IF) INFORMATION SKILLS:															
A. Acquires and evaluates information	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4
B. Organizes and maintains information	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4
C. Interprets and communicates information	X	X	X	X	X	X	X	X	X	X	X	X	X	X	3
(SY) SYSTEMS:															
A. Understands systems	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4
B. Monitors and corrects performance	X	X	X	X	X	X	X	X	X	X	X	X	X	X	3
C. Improves and designs systems				X											2
(TE) TECHNOLOGY:															
A. Selects technology	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4
B. Applies technology to task	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4
C. Maintains and troubleshoots technology		X	X	X	X	X	X	X	X	X	X	X	X		3

SCANS/Course

CROSSWALK

WELDING TECHNOLOGY	Basic Arc/Gas Welding I	Basic Arc/Gas Welding II	Electrical Welding Circuits	Reading Welding Blueprints	Advanced SMAW and Cutting I	Advanced SMAW and Cutting II	MIG, TIG and Brazing I	MIG, TIG and Brazing II	Basic Welding Metallurgy	Individual Welding Problems I	Individual Welding Problems II	Basic Pipe Welding I	Basic Pipe Welding II	Visual Inspection of Welds	EXIT PROFICIENCY LEVEL
(BS) BASIC SKILLS:															
A. Reading	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4
B. Writing	X	X	X	X	X	X	X	X	X	X	X	X	X	X	3
C. Arithmetic and mathematics				X											3
D. Listening	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4
E. Speaking	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4
(TS) THINKING SKILLS:															
A. Decision making	X	X	X	X	X	X	X	X	X	X	X	X	X	X	3
B. Problem solving	X	X	X	X	X	X	X	X	X	X	X	X	X	X	3
C. Seeing things in the mind's eye				X					X	X					2
D. Knowing how to learn	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4
E. Reasoning	X	X	X	X	X	X	X	X	X	X	X	X	X	X	3
(PQ) PERSONAL QUALITIES:															
A. Responsibility	X	X	X	X	X	X	X	X	X	X	X	X	X	X	3
B. Self-esteem	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4
C. Socialability	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4
D. Integrity/honesty	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4

WELDING TECHNOLOGY
SCANS
COMPETENCIES AND FOUNDATION SKILLS
EXIT LEVEL PROFICIENCY MATRIX

The Secretary's Commission on Achieving Necessary Skills (SCANS), U. S. Department of Labor, has identified in its "AMERICA 2000 REPORT" the following five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance:

COMPETENCIES:

Resources:	Identifies, organizes, plans, and allocates resources
Interpersonal:	Works with others
Information:	Acquires and uses information
Systems:	Understands complex inter-relationships
Technology:	Works with a variety of technologies

FOUNDATION SKILLS:

Basic Skills:	Reads, writes, performs arithmetic and mathematical operations, listens and speaks
Thinking Skills:	Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons
Personal Qualities:	Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty.

The following matrix identifies the five exit levels of proficiency that are needed for solid job performance.

EXIT LEVEL OF PROFICIENCY					
SCANS Competencies and Foundation Skills	**1**	**2**	**3**	**4**	**5**
	rarely	routinely with supervision	routinely with limited supervision	routinely without supervision	initiates/ improves/ modifies and supervises others

MAST/04012296

THE MAST COURSE SYLLABI
"PILOT PROGRAM"

MAST has produced a very unique set of course outlines, driven and validated by industry and encompassing the broad range of technologies covered by the MAST grant. The course outlines also include proposed SCANS activities that will be useful to an instructor in preparing students to enter the workforce of the future.

Included in the following pages are final course outlines developed and refined in the process of piloting the MAST training programs. The outlines include a brief course description; required course materials (e.g., textbook, lab manual, and tools, if available); proposed method of instruction; proposed lecture and lab outlines; and detailed course objectives for both Technical Workplace Competencies and SCANS Competencies.

These outlines were completed and revised during the second year of MAST, following completion of the pilot phase. The outlines are intended to serve as an aide to other instructional designers and faculty in community college programs across the nation.

Included on the following pages are the Course Syllabi for each of the courses which were taught during the pilot program.

***M*achine Tool *A*dvanced *S*kills**
***T*echnology Program**

MAST

COURSE SYLLABUS

BASIC ARC/GAS WELDING I

MAST PROGRAM
COURSE SYLLABUS
BASIC ARC/GAS WELDING I

Lecture hours/week: 1 **Lab hours/week: 4** **Credit hours: 3**

COURSE DESCRIPTION:

Basic Arc/Gas Welding I is the first half of the Basic Arc/Oxy-fuel Welding and Cutting course. The student will learn introductory skills in shielded metal, arc welding, oxy-acetylene welding and oxy-fuel cutting. The student will also learn safety procedures relating to these subjects and shop safety in general. This course will be taught using industrial procedures and guidelines. It features hands on welding instruction. Your participation is your key to success in this course.

PREREQUISITES: **NONE**

COURSE OBJECTIVES:

After the successful completion of this course the student will be able to:

A. Shielded Metal Arc Welding

1. Given a lecture and demonstration, the student will perform industrial housecleaning duties to instructor satisfaction
2. Given a lecture/discussion on welding, shop and hand tool safety, the student will identify safety rules and standards on written & oral tests to a Student Training Standard (B)
3. Given a lecture/discussion on welding terms the student will define selected terms on written tests to a Student Training Standard (B)
4. Given lecture/discussion/demonstration, the student will strike an arc and run continuous stringer beads in the flat (1G) position using bare rods and given electrodes to a Student Training Standard (2b/B)
5. Given lecture/discussion/demonstration, the student will run selected electrodes using the weave bead welding technique to a Student Training Standard (2b/B)
6. Given lecture/discussion on the A.W.S. mile steel shielded metal arc welding (SMAW) code the student will describe given electrodes on a written and/or oral exam to a Student Training Standard (B)
7. Given a lecture/discussion on direct current polarity for welding, the student will adjust the welding circuit to a given polarity to a Student Training Standard (2b/B)
8. Given a lecture/discussion/demonstration on correctly starting and stopping welding with SMAW electrodes (including low hydrogen electrodes), the student will produce weld beads having hot starts and correctly ended with filled weld craters to a Student Training Standard (2b/B)
9. Given a lecture/demonstration, the student will use 1/8" E6013 to weld a three layer build up on a plate using the "damming" technique and leaving no craters to a Student Training Standard (2b/B)

10. Given air carbon arc cutting equipment (ACA), the student will cut separate a welded butt joint to a Student Training Standard (2b/B)
11. The student will produce a college level five (5) page type written research paper on a welding topic. This topic must be approved by the instructor

B. Oxy-Fuel Cutting

1. Given a lecture/discussion on oxy-fuel cutting equipment, the student will safely setup and shut down oxy-fuel welding station according to manufacturers' recommended practice to a Student Training Standard (2b/A)
2. Given a discussion/demonstration on oxy-fuel cutting, the student will cut steel plate/sheet with oxy-fuel cutting equipment to a Student Training Standard (2b/A)

REQUIRED COURSE MATERIALS:

Textbook: Basic Arc Welding (SMAW), by Ivan H. Griffen, Edward M. Roden, Charles W. Briggs; Delmar

Supplies:

1. Safety glasses (which will be worn at all times in the welding lab)
2. Welder's helmet with Nos. 10-11 filter lenses
3. Heavy gauntlet style welder's gloves
4. Chipping hammer
5. Wire brush
6. Large pliers or vice grips
7. Appropriate clothing and shoes
8. Gas welding and cutting goggles (shade 5-6)
9. Flashlight
10. Spark lighter

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be "hands-on" activities.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments
2. apply theory to laboratory assignments
3. satisfactorily perform on written, oral, and practical examinations
4. satisfactorily perform on outside assignments including writing assignments
5. contribute to class discussions
6. maintain attendance per current policy
7. follow all shop rules and safety regulations as stated in the laboratory manual

LECTURE OUTLINE:

Lecture Topics	Text Reference Page	Contact Hrs.
Welding & Shop Safety	Unit #s 1, 2, 3, 4, 6	8
Polarity, AC & DC current		
How to adjust welding machine		
Six variables of SMAW	Unit # 7	1
How to light & shut down oxy-fuel terms		
Making tie-ins SMAW		
Cutting Movie		
How to oxy-acetylene weld	Unit # 8	1
How to run weave beads		
A.W.S. electrode code		1
Build up and hard surface	Unit # 9	1
TEST - Terms, Polarity, Safety, 6 variables of SMAW - oxy-fuel cutting		2
Review		2
Parts of a weld - fillet & groove		
Tie-ins, AWS electrode code		
Practical Test & Written Final		2
	Total Lecture Hours	**18**

LAB OUTLINE:

LabTopics	Contact Hrs.
Shielded Metal Arc Welding	
Perform Industrial Housecleaning Duties	
Strike an Arc and Run Continuous Stringer Beads in the Flat (1G) Position Using Bare Rods and Given Electrodes	
Run Selected Electrodes Using the Weave Bead Welding Technique	
Adjust the Welding Circuit to a Given Polarity	
Produce Weld Beads Having Hot Starts and Correctly Ended With Filled Weld Craters	
Use 1/8" E6013 to Weld a Three Layer Build Up on a Plate Using the "Damming" Technique and Leaving No Craters	
Cut Separate a Welded Butt Joint	
Oxy-Fuel Cutting	
Safely Set Up and Shut Down Oxy-Fuel Welding Station According to Manufacturers' Recommended Practice	
Cut Steel Plate/Sheet With Oxy-Fuel Cutting Equipment	—
Total Lab Hours	

COURSE OBJECTIVES: TECHNICAL COMPETENCIES

After the successful completion of this course the student will be able to:

A. FOLLOW SAFE PRACTICES

1. Wear Personal Protective Equipment
   a. List personal protective equipment for shielded metal arc welding
   b. List personal protective equipment for gas tungsten arc welding
   c. List personal protective equipment for gas metal arc welding
   d. List personal protective equipment for flux cored arc welding
   e. List personal protective equipment for submerged arc welding
   f. List personal protective equipment for oxy-fuel cutting
   g. List personal protective equipment for plasma arc cutting
   h. List personal protective equipment for air carbon arc gouging
   i. During shop work, wear applicable personal protective equipment at all times
2. Identify Safety Rules
   a. List environmental safety precautions i.e. fume control, radiation reflection, electrical consideration, fire hazards and control, etc.
   b. List equipment safety rules, i.e., ventilation, grounding, duty cycle
   c. Utilize safety when handling and storing compressed gas cylinders
   d. List general shop safety rules
   e. Maintain safe conditions in workstation. Student demonstrate by setting up safe workstation.
   f. Comply with confined space entry safety procedures
   g. Conduct a safety inspection of the student work area
   h. Conduct a safety inspection of the welding shop
   i. Conduct a safety inspection of the gas storage area
3. Familiarize Oneself With Safety at Facility
   a. Attend safety tour of welding lab
   b. Receive a safety orientation lecture
   c. Avoid fumes through proper ventilation and good practices
   d. Operate exhaust system
   e. Practice electric safety with respect to welding
   f. Protection from radiation with an understanding of personal safety equipment and conduct
   g. Demonstrate a knowledge of fire prevention and protection for welding in dress and conduct
   h. List welding and cutting safety rules
   i. Demonstrate oxy-fuel gas cutting safety
   j. Demonstrate arc welding safety

B. DEMONSTRATE TECHNICAL COMMUNICATION

1. Use Standard American Welding Standard Society Welding Terms and Definitions
   a. Follow verbal instructions
   b. Follow written details
   c. Prepare time and job cards (reports & records)

C. BASIC SHIELDED METAL ARC WELDING (SMAW) AND OXY-FUEL GAS CUTTING

1. Define Selected Welding Terms Per AWS A3.0

a. Define arc welding process terms
b. Define standard joint terminology
c. Define common weld discontinuities
d. Name welding equipment, supply and consumables
e. Define common shop terms including proper equipment names
f. Define material terms
g. Define common metallurgy terms

2. Describe AWS Code for Mild Steel Electrodes
   a. List, describe and define
   b. List low hydrogen electrodes
   c. List iron powder electrodes
   d. Describe electrode by welding position
   e. Describe electrode by current and polarity
   f. Describe electrode by penetration
3. Set Up Welding Machine to Required Polarity
   a. List polarities for commonly used electrodes
   b. Describe both polarities
   c. Describe advantages and disadvantages of alternating current
4. Use Correct Start and Stop Techniques for SMAW Electrodes
   a. Describe and demonstrate start for non-low hydrogen SMAW electrode
   b. Describe and demonstrate stop for non-low hydrogen SMAW electrodes with filled craters
   c. List reasons for the importance of low hydrogen in weld metal
   d. Explain the reason for low hydrogen starts and stops and how they work and why required specifically with E7018
5. Set Up Equipment for Shielded Metal Arc Welding
   a. Inspect area for safety
   b. Adjust current and polarity for specific job requirements
   c. Choose type and size of electrode
   d. Wear applicable personal safety equipment
6. Strike an Arc, Run Continuous Stringer Bead
   a. Stand and position oneself correctly
   b. Operate welding helmet
   c. Verbally warn others of intent to arc weld
   d. Strike an arc
   e. Weld with stringer bead technique
   f. Perform weld tie in's to make continuous bead
7. Weld Using Weave Technique
   a. Maintain required weld quality
   b. Maintain proper weld width uniformly
   c. Maintain proper travel speed
   d. Match correct oscillation for various electrodes
   e. Match applications to weave techniques, as they apply
   f. List the advantages and disadvantages of weave techniques
   g. List the advantages and disadvantages of stringer techniques
   h. Perform weld using weave technique
   i. Concentrate on dwell times at edges of weld pool
8. Weld Multi-Layer Buildup

a. Weld a dam to outline area being welded for each layer
b. Apply each layer neatly, straight and with good fusion throughout
c. Chip slag after each pass
d. Weld passes which over lap to crown of last weld bead
e. Demonstrate control of bead height

9. Set Up and Shut Down Oxy-Fuel Equipment
   a. Follow manufacturer's recommended practice
   b. Inspect equipment and work area for safety
   c. Assemble oxy-fuel equipment
   d. Open fuel gas cylinder ½ turn
   e. Open oxygen as cylinder all the way
   f. Adjust fuel gas and oxygen working pressure per manufacturer's recommendation
   g. Purge lines one at a time. One second for each 10 feet of hose length
10. Cut Steel Plate Using Oxy-Fuel Equipment
   a. Make manual free hand straight line cuts
   b. Cut manually straight lines using cutting jib
   c. Bevel plate with manual oxy-fuel equipment
   d. Manually cut blind holes in thick material
   e. Manually cut sheet metal with minimal distortion
11. Produce Welds with Properly Fused Starts and Filled Craters
   a. Use non-low hydrogen electrodes
   b. Strike arc and hold long arc length 1" away from last weld crater
   c. Back-up to previous weld crater holding long arc length
   d. Pre-heat crater with long arc
   e. Shorten arc length, fill crater and continue welding

D. MAINTAIN HOUSEKEEPING

1. Clean Work Area and Insure That No Safety Hazards Exist
   a. Sweep table top and floor in work area
   b. Clean equipment and tools
   c. Return tools to proper storage area
   d. Dispose of waste materials and scrap in their proper receptacle containers and storage areas
   e. Store all unused materials to their respective storage areas

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U. S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance.

The following activities will be performed by each student for successful completion of this course:

I. **COMPETENCIES**

A. ***Resources:*** *Identifies, organizes, plans, and allocates resources*
   1. self paced instruction with very little supervision requires time management
   2. projects require materials acquisition

B. ***Interpersonal:*** *Works with others*
   1. lab and class requires team work and cooperation to complete projects
   2. safety requires mutual cooperation, vigilance and communication

C. ***Information:*** *Acquires and uses information*
   1. reading assignments contain material students are responsible for which are to be obtained no where else
   2. lecture notes and research paper
   3. this is demonstrated by student's ability to complete projects

D. ***Systems:*** *Understands complex inter-relationships*
   1. program is geared toward training students to work and operate technology and system
   2. as the students learn welding skills they learn to monitor and correct their own performance

E. ***Technology:*** *Works with a variety of technologies*
   1. projects require selection of various technologies
   2. all projects require applied technology
   3. constant trouble shooting is required

II. **FOUNDATION SKILLS**

A. ***Basic Skills:*** *Reads, writes, performs arithmetic and mathematical operations, listens and speaks.*

   1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
      a. reads and comprehends homework assignments
      b. reads complicated written instruction

   2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
      a. completes written assignments and reports
      b. completes written essay questions

   3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
      a. converts fractions to decimals
      b. converts decimals to fractions
      c. adds, subtracts, multiplies and divides fractions
      d. computes angles

   4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
      a. attends lectures
      b. interprets complicated verbal instructions

   5. ***Speaking:*** *Organizes ideas and communicates orally*
      a. responds to oral quiz questions
      b. capsulizes lecture information

B. ***Thinking Skills:*** *Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons.*

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   a. identifies personal goals
   b. identifies actions required to accomplish personal goals
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. answer assigned questions
   b. makes daily accommodations to stay on schedule
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. understands both written and verbal instructions
   b. understands step by step procedure to produce given tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. tasks require individualized practice to develop learning skills
   b. recognizes information to solve specific problems
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. understands welding terminology
   b. interprets different welding techniques
   c. chooses processes to accomplish specific tasks
   d. chooses procedures to accomplish specific tasks

C. ***Personal Qualities:*** *Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty.*

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. develops good work ethic
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. achievement in class objectives
   b. ability to learn very challenging tasks
   c. successfully completes tasks with quality results
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. working together with other students in safety
   b. working together with other students in learning
   c. assigned to group projects and assignments
4. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. accepts responsibility for own actions
   b. exhibits personal honesty at all times
   c. works with expensive tools and equipment - prompted to report all problems

*M*achine Tool *A*dvanced *S*kills
*T*echnology Program

MAST

COURSE SYLLABUS

BASIC ARC/GAS WELDING II

MAST PROGRAM
COURSE SYLLABUS
BASIC ARC/GAS WELDING II

Lecture hours/week: 1 **Lab hours/week: 4** **Credit hours: 3**

COURSE DESCRIPTION:

Basic Arc/Gas Welding II is the second half of the Basic Arc/Gas Welding I course. This hands-on class expands the student's knowledge and experience in using various types of shielded metal arc welding electrodes in the flat and horizontal positions. The student will advance to welding single "V" groove welds in the 1G or flat position.

PREREQUISITES: Basic Arc/Gas Welding I

COURSE OBJECTIVES:

After the successful completion of this course the student will be able to:

A. Shielded Metal Arc Welding

1. Given a welding and shop safety test, the student will pass with a minimum score of 100%
2. Given lab assignments, the student will conduct himself/herself in a safe manner at all times to a Student Training Standard (B)
3. Given a lecture/discussion on welding terms, the student will define selected term on written tests to a Student Training Standard (B)
4. Given lecture/discussion/demonstration, the student will run selected electrodes using the weave bead welding technique to a Student Training Standard (3c/B)
5. Given lecture/discussion on the A.W.S. mild steel shielded metal arc welding (SMAW) code, the student will describe given electrodes on a written and/or oral exam to a Student Training Standard (B)
6. Given a lecture/discussion on direct current polarity for welding, the student will adjust the circuit to a given polarity to a Student Training Standard (2b/B)
7. Given a lecture/discussion/demonstration on correctly starting and stopping welding with SMAW electrodes (including low hydrogen electrodes), the student will produce weld beads having hot starts and correctly ended with filled weld craters to a Student Training Standard (2b/B)
8. Given a lecture/discussion on the five basic joint configurations, the student, given a joint name, will draw the joint to a Student Training Standard (2b/B)
9. Given a lecture/discussion/demonstration, the student will weld using large diameter electrodes: 3/16", 1/4" and 5/16" in the flat and horizontal positions to a Student Training Standard (2b/B)
10. Given a lecture/discussion/demonstration, the student will weld single "V" groove welds in the 1G position using stringer bead and weave bead techniques to a Student Training Standard (2b/B)

11. Given a lecture/discussion/demonstration, the student will use air carbon arc cutting (ACA) equipment to gouge and repair single "V" groove welds
12. Given lecture/discussion/demonstration, the student will weld fillets on sheet steel in the .063" to .125" thickness range using S.M.A.W. to a Student Training Standard (2b/B)
13. Given lecture/discussion/demonstration, the student will weld various joint configurations of thick to thin material using given electrodes to a Student Training Standard (2b/B)

B. Oxy-Fuel Cutting

1. All material used in class will be prepared using oxy-fuel cutting. Grinding will be kept to an absolute minimum
2. Oxy-fuel skill will be graded on improvement over class. Students are expected to hold cutting to plus or minus 1/16"

REQUIRED COURSE MATERIALS:

Textbook: Basic Arc Welding (SMAW), by Ivan H. Griffen, Edward M. Roden, Charles W. Briggs; Delmar

Supplies:

1. Safety glasses (which will be worn at all times in the welding lab)
2. Welder's helmet with Nos. 10-11 filter lenses
3. Heavy gauntlet style welder's gloves
4. Chipping hammer
5. Wire brush
6. Large pliers or vice grips
7. Appropriate clothing and shoes
8. Gas welding and cutting goggles (shade 5-6)
9. Coarse half-round file

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be "hands-on" activities.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments
2. apply theory to laboratory assignments
3. satisfactorily perform on written, oral, and practical examinations
4. satisfactorily perform on outside assignments including writing assignments
5. contribute to class discussions
6. maintain attendance per current policy
7. follow all shop rules and safety regulations as stated in the laboratory manual

LECTURE OUTLINE:

Lecture Topics	Text Reference Page	Contact Hrs.
Review Arc Welding & Oxy-Fuel Safety	Unit 8, 14 and 15	1
Welding Techniques and Heat Input	Unit 20	2
Weld Discontinuities	Unit 23	4
Prepare a Welding Procedure	Unit 19	2
Prepare a Welding Procedure	Unit 18	2
Turn in Welding Procedure	Unit 8	2
Qualify Procedure	Unit 24	3
Review for Final	Unit 26	2
	Total Lecture Hours	**18**

LAB OUTLINE:

LabTopics	Contact Hrs.
Run Selected Electrodes Using the Weave Bead Welding Technique	
Adjust the Circuit to a Given Polarity	
Produce Weld Beads Having Hot Starts and Correctly Ended With Filled Weld Craters	
Weld Using Large Diameter Electrodes: 3/16", 1/4" and 5/16" in the Flat and Horizontal Positions	
Weld Single "V" Groove Welds in the 1G Position Using Stringer Bead and Weave Bead Techniques	
Use Air Carbon Arc Cutting (ACA) Equipment to Gouge and Repair Single "V" Groove Welds	
Weld Fillets on Sheet Steel in the .063" to .125" Thickness Range Using SMAW	
Weld Various Joint Configurations of Thick to Thin Material Using Given Electrodes	
Total Lab Hours	—

COURSE OBJECTIVES: TECHNICAL COMPETENCIES

After the successful completion of this course the student will be able to:

A. FOLLOW SAFE PRACTICES

1. Wear Personal Protective Equipment
   - a. List personal protective equipment for shielded metal arc welding
   - b. List personal protective equipment for gas tungsten arc welding
   - c. List personal protective equipment for gas metal arc welding
   - d. List personal protective equipment for flux cored arc welding
   - e. List personal protective equipment for submerged arc welding
   - f. List personal protective equipment for oxy-fuel cutting
   - g. List personal protective equipment for plasma arc cutting

h. List personal protective equipment for air carbon arc gouging
i. During shop work, wear applicable personal protective equipment at all times

2. Identify Safety Rules
   a. List environmental safety precautions i.e. fume control, radiation reflection, electrical consideration, fire hazards and control, etc.
   b. List equipment safety rules, i.e., ventilation, grounding, duty cycle
   c. Utilize safety when handling and storing compressed gas cylinders
   d. List general shop safety rules
   e. Maintain safe conditions in workstation. Student demonstrate by setting up safe workstation.
   f. Comply with confined space entry safety procedures
   g. Conduct a safety inspection of the student work area
   h. Conduct a safety inspection of the welding shop
   i. Conduct a safety inspection of the gas storage area

3. Familiarize Oneself With Safety at Facility
   a. Attend safety tour of welding lab
   b. Receive a safety orientation lecture
   c. Avoid fumes through proper ventilation and good practices
   d. Operate exhaust system
   e. Practice electric safety with respect to welding
   f. Protection from radiation with an understanding of personal safety equipment and conduct
   g. Demonstrate a knowledge of fire prevention and protection for welding in dress and conduct
   h. List welding and cutting safety rules
   i. Demonstrate oxy-fuel gas cutting safety
   j. Demonstrate arc welding safety

B. DEMONSTRATE TECHNICAL COMMUNICATION

1. Use Standard American Welding Standard Society Welding Terms and Definitions
   a. Follow verbal instructions
   b. Follow written details
   c. Prepare time and job cards (reports & records)

C. BASIC SHIELDED METAL ARC WELDING (SMAW) AND OXY-FUEL GAS CUTTING

1. Define Selected Welding Terms Per AWS A3.0
   a. Define arc welding process terms
   b. Define standard joint terminology
   c. Define common weld discontinuities
   d. Name welding equipment, supply and consumables
   e. Define common shop terms including proper equipment names
   f. Define material terms
   g. Define common metallurgy terms

2. Describe AWS Code for Mild Steel Electrodes
   a. List, describe and define
   b. List low hydrogen electrodes
   c. List iron powder electrodes
   d. Describe electrode by welding position

e. Describe electrode by current and polarity
f. Describe electrode by penetration

3. Set Up Welding Machine to Required Polarity
   a. List polarities for commonly used electrodes
   b. Describe both polarities
   c. Describe advantages and disadvantages of alternating current
4. Use Correct Start and Stop Techniques for SMAW Electrodes
   a. Describe and demonstrate start for non-low hydrogen SMAW electrode
   b. Describe and demonstrate stop for non-low hydrogen SMAW electrodes with filled craters
   c. List reasons for the importance of low hydrogen in weld metal
   d. Explain the reason for low hydrogen starts and stops and how they work and why required specifically with E7018
5. Set Up Equipment for Shielded Metal Arc Welding
   a. Inspect area for safety
   b. Adjust current and polarity for specific job requirements
   c. Choose type and size of electrode
   d. Wear applicable personal safety equipment
6. Strike an Arc, Run Continuous Stringer Bead
   a. Stand and position oneself correctly
   b. Operate welding helmet
   c. Verbally warn others of intent to arc weld
   d. Strike an arc
   e. Weld with stringer bead technique
   f. Perform weld tie in's to make continuous bead
7. Weld Using Weave Technique
   a. Maintain required weld quality
   b. Maintain proper weld width uniformly
   c. Maintain proper travel speed
   d. Match correct oscillation for various electrodes
   e. Match applications to weave techniques, as they apply
   f. List the advantages and disadvantages of weave techniques
   g. List the advantages and disadvantages of stringer techniques
   h. Perform weld using weave technique
   i. Concentrate on dwell times at edges of weld pool
8. Weld Multi-Layer Buildup
   a. Weld a dam to outline area being welded for each layer
   b. Apply each layer neatly, straight and with good fusion throughout
   c. Chip slag after each pass
   d. Weld passes which over lap to crown of last weld bead
   e. Demonstrate control of bead height
9. Set Up and Shut Down Oxy-Fuel Equipment
   a. Follow manufacturer's recommended practice
   b. Inspect equipment and work area for safety
   c. Assemble oxy-fuel equipment
   d. Open fuel gas cylinder ½ turn
   e. Open oxygen as cylinder all the way

f. Adjust fuel gas and oxygen working pressure per manufacturer's recommendation
g. Purge lines one at a time. One second for each 10 feet of hose length

10. Cut Steel Plate Using Oxy-Fuel Equipment
    a. Make manual free hand straight line cuts
    b. Cut manually straight lines using cutting jib
    c. Bevel plate with manual oxy-fuel equipment
    d. Manually cut blind holes in thick material
    e. Manually cut sheet metal with minimal distortion
11. Low Hydrogen Starts and Stops
    a. Use low hydrogen electrodes
    b. Strike arc 1" from crater
    c. Immediately shorten arc length and back up quickly previous weld crater. Holding short arc length
    d. Pause at the crater when it is filled. Continue welding
12. Design Welded Joints
    a. List the names and draw side views of the five basic joint configurations
    b. List the names and draw side views of the variations of grooves
    c. List the names and draw side views of the T-Joint variations
    d. List the name of the type of weld made in each joint
13. Weld V Groove With Backing in Flat Position
    a. Use oxy-fuel equipment to bevel 3/8" steel to 37 1/2°
    b. Clean bevel face with grinder as required
    c. Cut 1/4" material for backing strip
14. Use Air Carbon Arc to Excavate a Partial Pen Groove Weld
    a. Locate root of weld
    b. Demonstrate control of depth of cut
    c. Demonstrate control of width of cut
    d. Use air carbon arc cutting equipment to make shallow gouges (about 1/8" deep max.) with stringer technique
    e. Make gouges of uniform depth
    f. Observe discontinuities as gouging proceeds
    g. Gouge until some weld metal is reached
15. Gouge to Excavate Defect
    a. Given the area of suspected discontinuity its size and depth; air carbon 1 gouge using multi pass and stringer gouge to defect depth
    b. Measure to make sure excavation is at proper location and depth
    c. Use air carbon arc equipment. Shape excavation to ensure proper fusion
    d. Clean area of all scale, carbon etc.
16. Make X-Ray Quality Weld Repair on a 2F Position T Joint ½" Plate
    a. Check area for safety
    b. Set SMAW equipment current and polarity for 1/8" E7018
    c. Attach work lead
    d. Preheat and maintain interpass temperature as required
    e. Weld first pass paying special attention to low hydrogen techniques
    f. Grind the weld start and stop to remove cold lap and lack of fusion
    g. Weld the second pass starting from opposite end
    h. Repeat starts and stops until weld is completed

i. Inspect and submit for non-destructive testing RT or UT

17. Produce Fillet Weld on Sheet Steel T Joints
    a. Check work area for safety
    b. Position steel in a T joint and tack at ends
    c. Place T joint in the 2F position with a spacer on each end so the workpiece is not touching the work bench. This stops any heat sink.
    d. Produce fillet welds equal in size to the thickness of the smallest joint member. With SMAW E6011, E6013 and GMAW and GTAW
    e. Visually inspect to AWS D1.3
18. Produce Fillet Welds on T Joints Made Up of Both Thick and Thin Joint Members Using SMAW
    a. Inspect work area for safety
    b. Set SMAW equipment for type and size of electrode and job requirements
    c. Fit up and tack joint
    d. Weld joint keeping the major portion of heat on thicker section
    e. Clean and visually inspect
19. Use Correct Starts for Low Hydrogen Electrodes
    a. List the AWS steel electrode code last digit designation for low hydrogen electrode
    b. Set up SMAW e.g. and check for safety
    c. Using E7018 strike an arc 1" down the path of welding from where you wish to start
    d. Shorten arc length immediately to low hydrogen arc length
    e. Quickly approximate 3 times as fast as welding travel speed back up the one inch to the point at which the weld should start
    f. Stop movement at starting point and allow weld pool to form
    g. Begin normal travel speed once weld pool reaches required diameter
20. Use Correct Stops for Low Hydrogen Electrodes
    a. Use E7018 to begin weld correctly
    b. Stop increase weld travel speed
    c. Observe weld pool when weld pool size decreases to smallest possible size, break off arc by pulling away
21. Weld Using Large Diameter SMA Electrodes
    a. Set up SMAW equipment for use with 3/16" and E7018
    b. Tack up a T joint using ½" steel
    c. Set amperage from 180 to 200 DC amps
    d. Begin the weld with a low hydrogen start by using a 75° lead angle (To fight arc blow)
    e. Bring lead angle back to normal as the weld progresses 2" along joint
    f. Begin changing the lead angle to a push or forehand angle of 70° to 80° 3" from the end of joint
    g. Make multi-pass fillet welds with smooth contour
    h. Visually inspect to insure

D. MAINTAIN HOUSEKEEPING

1. Clean Work Area and Insure That No Safety Hazards Exist
    a. Sweep table top and floor in work area
    b. Clean equipment and tools
    c. Return tools to proper storage area

d. Dispose of waste materials and scrap in their proper receptacle containers and storage areas
e. Store all unused materials to their respective storage areas

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U. S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance.

The following activities will be performed by each student for successful completion of this course:

I. **COMPETENCIES**
- *A.* ***Resources:*** *Identifies, organizes, plans, and allocates resources*
  1. self paced instruction with very little supervision requires time management
  2. projects require materials acquisition
- *B.* ***Interpersonal:*** *Works with others*
  1. lab and class requires team work and cooperation to complete projects
  2. safety requires mutual cooperation, vigilance and communication
- *C.* ***Information:*** *Acquires and uses information*
  1. reading assignments contain material students are responsible for which are to be obtained no where else
  2. lecture notes and research paper
  3. this is demonstrated by student's ability to complete projects
- *D.* ***Systems:*** *Understands complex inter-relationships*
  1. program is geared toward training students to work and operate technology and system
  2. as the students learn welding skills they learn to monitor and correct their own performance
- *E.* ***Technology:*** *Works with a variety of technologies*
  1. projects require selection of various technologies
  2. all projects require applied technology
  3. constant trouble shooting is required

II. **FOUNDATION SKILLS**
- *A.* ***Basic Skills:*** *Reads, writes, performs arithmetic and mathematical operations, listens and speaks.*
  - *1.* ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
    a. reads and comprehends homework assignments
    b. reads complicated written instruction

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
   a. completes written assignments and reports
   b. completes written essay questions
3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. converts fractions to decimals
   b. converts decimals to fractions
   c. adds, subtracts, multiplies and divides fractions
   d. computes angles
4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. attends lectures
   b. interprets complicated verbal instructions
5. ***Speaking:*** *Organizes ideas and communicates orally*
   a. responds to oral quiz questions
   b. capsulizes lecture information

B. ***Thinking Skills:*** *Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons.*
1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   a. identifies personal goals
   b. identifies actions required to accomplish personal goals
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. answer assigned questions
   b. makes daily accommodations to stay on schedule
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. understands both written and verbal instructions
   b. understands step by step procedure to produce given tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. tasks require individualized practice to develop learning skills
   b. recognizes information to solve specific problems
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. understands welding terminology
   b. interprets different welding techniques
   c. chooses processes to accomplish specific tasks
   d. chooses procedures to accomplish specific tasks

C. ***Personal Qualities:*** *Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty.*
1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. develops good work ethic

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. achievement in class objectives
   b. ability to learn very challenging tasks
   c. successfully completes tasks with quality results
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. working together with other students in safety
   b. working together with other students in learning
   c. assigned to group projects and assignments
4. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. accepts responsibility for own actions
   b. exhibits personal honesty at all times
   c. works with expensive tools and equipment - prompted to report all problems

Machine Tool Advanced Skills
Technology Program

MAST

COURSE SYLLABUS

ELECTRICAL WELDING CIRCUITS

MAST PROGRAM
COURSE SYLLABUS
ELECTRICAL WELDING CIRCUITS

Lecture hours/week: 2 **Lab hours/week: 0** **Credit hours: 2**

COURSE DESCRIPTION:

Theory and operation of the welding power source, welding circuits and welding equipment.

PREREQUISITES: **NONE**

COURSE OBJECTIVES:

After the successful completion of this course the student will be able to:

1. Give a lecture/discussion on welding shop safety and safety in using welding and cutting equipment
2. Given a lecture/discussion on welding processes used in industry, students will identify tools and equipment used in various welding processes
3. Given a lecture/discussion on oxy-acetylene cutting torch system, students will identify various types of equipment and set up oxy-fuel cutting stations in shop
4. Exam - on topics covered in first three weeks. Given lecture and discussions on single and two stage regulators, students will be able to identify various types of regulators used in industry
5. Given a lecture/discussion on various types of alternate fuel gasses, students will identify and understand advantages and disadvantages in using propane, butane, MAPP and acetylene and natural gas
6. Given a lecture/discussion on Shield Metal Arc Welding process, students will identify various parts and controls on Shield Metal Arc Welding power supplies and perform various tasks in setting up welding system in weld shop
7. Given a lecture/discussion on stick electrodes, students will identify various electrodes used in industry today
8. Given a lecture/discussion on duty cycle of a welding power supply, students will be able to understand and explain the various duty cycles used
9. (Mid-Term Examination) on topics discussed and explained on first half of course
10. Given a lecture/discussion on Gas Metal Arc Welding power sources, students will identify difference between GMAW & SMAW power supplies
11. Given a lecture/discussion on wire feed systems & MIG welding guns, students will perform various tasks in shop, set-up wire feed systems, change liners, tips, nozzles in MIG guns
12. Given a lecture/discussion on Argun based shielding gases, students will identify advantages and disadvantages of using Argun gas vs. CO_2 gas
13. Given a lecture/discussion on various types of GMAW welding electrodes, student will identify differences between flux cored electrode and solid GMA welding electrode

14. Given a lecture/discussion on stainless steel and aluminum welding, students will identify various grades of stainless steel and aluminum used in industry, as well as identify various processes used to weld them
15. Given a lecture/discussion on Gas Tungsten Arc Welding power sources, students will identify theory and be able to perform various tasks in shop setting up TIG welding system, as well as be able to change tungstens, collets, etc. and power cables on TIG torch
16. Given a lecture/discussion on plasma arc cutting systems, students will identify theory and be able to assemble systems, change various parts on plasma cutting torch, including changing of tips, electrodes, gear shields and power cables
17. (Final Examination) on all topics discussed and explained throughout the course

REQUIRED COURSE MATERIALS:

Textbook: **Welding Processes and Power Sources**, by Edward R. Pierre

Supplies: None required

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments
2. apply theory to laboratory assignments
3. satisfactorily perform on written, oral, and practical examinations
4. satisfactorily perform on outside assignments including writing assignments
5. contribute to class discussions
6. maintain attendance per current policy
7. follow all shop rules and safety regulations as stated in the laboratory manual

LECTURE OUTLINE:

Lecture Topics	Text Reference Page	Contact Hrs.
Safety	Chapters 2, 4	4
Identify tools	Chapters 2, 4	2
Set up and identify oxy-fuel	Chapters 2, 4	3
Regulators: identify and applications	Chapters 5, 6, 7, 9, 10, 11, 12	3
Fuel gas applications	Chapters 5, 6, 8, 9, 10, 11, 12	3
SMAW equipment process and set up	Chapters 15, 20	3
Electrode codes and specification		3
Understand and explain duty cycle	Chapters 7, 20	3
Review 3	Chapters 17, 18, 19, 20	3
GMAW compared to SMAW; List GMAW equipment	Chapters 13, 14, 15, 16, 18, 20	3

GTAW process and shielding gas		
applications GTAW and GMAW	Chapter 20	2
Plasma arc applications	Chapter 22	3
Plasma arc applications and inverters		
Review		
	Total Lecture Hours	**36**

COURSE OBJECTIVES: TECHNICAL COMPETENCIES

After the successful completion of this course the student will be able to:

A. FOLLOW SAFE PRACTICES

1. Wear Personal Protective Equipment
   a. List personal protective equipment for shielded metal arc welding
   b. List personal protective equipment for gas tungsten arc welding
   c. List personal protective equipment for gas metal arc welding
   d. List personal protective equipment for flux cored arc welding
   e. List personal protective equipment for submerged arc welding
   f. List personal protective equipment for oxy-fuel cutting
   g. List personal protective equipment for plasma arc cutting
   h. List personal protective equipment for air carbon arc gouging
   i. During shop work, wear applicable personal protective equipment at all times
2. Identify Safety Rules
   a. List environmental safety precautions i.e. fume control, radiation reflection, electrical consideration, fire hazards and control, etc.
   b. List equipment safety rules, i.e., ventilation, grounding, duty cycle
   c. Utilize safety when handling and storing compressed gas cylinders
   d. List general shop safety rules
   e. Maintain safe conditions in workstation. Student demonstrate by setting up safe workstation.
   f. Comply with confined space entry safety procedures
   g. Conduct a safety inspection of the student work area
   h. Conduct a safety inspection of the welding shop
   i. Conduct a safety inspection of the gas storage area
3. Familiarize Oneself With Safety at Facility
   a. Attend safety tour of welding lab
   b. Receive a safety orientation lecture
   c. Avoid fumes through proper ventilation and good practices
   d. Operate exhaust system
   e. Practice electric safety with respect to welding
   f. Protection from radiation with an understanding of personal safety equipment and conduct
   g. Demonstrate a knowledge of fire prevention and protection for welding in dress and conduct
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   i. Demonstrate oxy-fuel gas cutting safety

j. Demonstrate arc welding safety

B. DEMONSTRATE TECHNICAL COMMUNICATION

1. Use Standard American Welding Standard Society Welding Terms and Definitions
   a. Follow verbal instructions
   b. Follow written details
   c. Prepare time and job cards (reports & records)

C. GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
   a. Install adapter for particular brand of wire feeder
   b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
   c. Screw on gas defuser and tighten allen screw
   d. Install contact tip
   e. Install gas nozzle
   f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
   a. Compare and contrast constant current and constant voltage power sources
   b. List effects of inductance on circuit
   c. List effects of pinch effect
3. Shielding Gas Application
   a. List arc characteristics caused by welding with 100% carbon dioxide
   b. List arc characteristics caused by welding with 100% argon
   c. List arc characteristics caused by welding with 75% Argon and 25% CO2
   d. List arc characteristics caused by welding with 95% Argon and 5% CO2
   e. List arc characteristics caused by welding with 95% Argon and 5% oxygen

D. GAS TUNGSTEN ARC WELDING (GTAW)

1. Understand Technical Aspects of GTAW
   a. List advantages and disadvantages of GTAW
   b. List five applications where GTAW or PAW are better suited
   c. List give applications which are more suited to SMAW than GTAW
   d. Compare and contrast GTAW and plasma arc welding (PAC)
   e. List by name the parts of a GTAW torch
   f. Describe each control by name and function on the pulsed TIG system such as a Lincoln square wave 350 or Miller syncrowave 351 P.
   g. Assemble the GTAW torch, water cooler and GTAW machine

E. MAINTAIN HOUSEKEEPING

1. Clean Work Area and Insure That No Safety Hazards Exist
   a. Sweep table top and floor in work area
   b. Clean equipment and tools
   c. Return tools to proper storage area
   d. Dispose of waste materials and scrap in their proper receptacle containers and storage areas
   e. Store all unused materials to their respective storage areas

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  2. as the students learn welding skills they learn to monitor and correct their own performance
- *E.* ***Technology:*** *Works with a variety of technologies*
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  2. all projects require applied technology
  3. constant trouble shooting is required

II. **FOUNDATION SKILLS**

- *A.* ***Basic Skills:*** *Reads, writes, performs arithmetic and mathematical operations, listens and speaks.*
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    - b. reads complicated written instruction
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    - a. completes written assignments and reports
    - b. completes written essay questions

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. converts fractions to decimals
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   a. identifies personal goals
   b. identifies actions required to accomplish personal goals
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. answer assigned questions
   b. makes daily accommodations to stay on schedule
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. understands both written and verbal instructions
   b. understands step by step procedure to produce given tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. tasks require individualized practice to develop learning skills
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   a. understands welding terminology
   b. interprets different welding techniques
   c. chooses processes to accomplish specific tasks
   d. chooses procedures to accomplish specific tasks

C. ***Personal Qualities:*** *Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty.*
1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. develops good work ethic
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. achievement in class objectives
   b. ability to learn very challenging tasks

c. successfully completes tasks with quality results

3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. working together with other students in safety
   b. working together with other students in learning
   c. assigned to group projects and assignments

4. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. accepts responsibility for own actions
   b. exhibits personal honesty at all times
   c. works with expensive tools and equipment - prompted to report all problems

*M*achine Tool *A*dvanced *S*kills
*T*echnology Program

MAST

COURSE SYLLABUS

READING WELDING BLUEPRINTS

MAST PROGRAM
COURSE SYLLABUS
READING WELDING BLUEPRINTS

Lecture hours/week: 3 **Lab hours/week: 0** **Credit hours: 3**

COURSE DESCRIPTION:

Introduction to blueprint reading for welding emphasizes basic interpretation of blueprints, welding symbols and basic sketching.

PREREQUISITES: **NONE**

COURSE OBJECTIVES:

After the successful completion of this course the student will be able to read blueprints, involving weldments which includes:

1. Interpretation of drawing lines, views & symbols
2. Interpretation of welding symbols
3. Understanding of converting metric dimensions & English dimensions and vice versa
4. Understanding of specifications per print
5. Understanding of assembly procedure per print
6. Understanding variation in types of welding prints
7. Visualization of final weldment
8. Recognizing of flaws and mistakes on drawings

REQUIRED COURSE MATERIALS:

Textbook: **Print Reading for Welders**, 2nd Edition
Symbols for Welding & Non-Destructive Testing, A.W.S., A2.4-84

Supplies: None required

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. satisfactorily perform on written, oral, and practical examinations
2. satisfactorily perform on outside assignments including writing assignments
3. contribute to class discussions
4. maintain attendance per current policy

LECTURE OUTLINE:

Lecture Topics	Text Reference Page	Contact Hrs.
Meaning of views and lines (includes symbols and nomenclature, visualization of objects and drawings of views & sections)		6
Size description (includes units of measurement, dimensioning tolerances)		4
Conversions (metric to English units and vice versa)		5
Basic elements of welding prints (includes drawing systems, types of fabrication prints, title blocks, revisions, variations in different company standards, parts materials lists)		6
Threaded fasteners and machine terminology		4
Basic welding terms		4
Welding symbols		6
Pitfalls to avoid and errors to watch for on welding		4
Prints (why things work on paper but not in practice)		4
Working with codes on welding prints		4
Review		7
	Total Lecture Hours	**54**

COURSE OBJECTIVES: TECHNICAL COMPETENCIES

After the successful completion of this course the student will be able to:

A. DEMONSTRATE TECHNICAL COMMUNICATION

1. Use Standard American Welding Standard Society Welding Terms and Definitions
   a. Follow verbal instructions
   b. Follow written details
   c. Prepare time and job cards (reports & records)

B. INTERPRET WELDING DRAWINGS

1. Review Print Notes, Dimensions and Symbols
   a. Interpret AWS standard welding symbols
   b. List essential components found in general notes on drawing
   c. Determine acceptable tolerances for drawing
   d. Determine code requirements, process and procedure requirements required by drawing
   e. Interpret 3 view drawings
   f. Work from drawings, prints and sketches
2. Identify Basic Layouts of Drawings
3. Interpret Drawing Lines and Views
4. Interpret Welding Symbols
5. Convert Metric to English

6. Understand Print Specifications
7. List Assembly Procedure Per Print
8. Understand Various Types of Welding Prints
9. Visualize Final Weldment From Print
10. List Flaws and Errors on Drawings
11. Interpret AWS Standard Welding Symbols

C. **MATHEMATICAL SKILLS**

1. Determine Measurements and Angles
   a. Add fractions
   b. Subtract fractions
   c. Multiply fractions
   d. Divide fractions
   e. Change fractions to decimals
   f. Change decimals to fractions
   g. Solve simple algebraic equations
   h. Solve simple trigonometric equations
   i. Convert English measurement to Metric
   j. Convert Metric measurement to English

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U. S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance.

The following activities will be performed by each student for successful completion of this course:

I. **COMPETENCIES**

A. ***Resources:*** *Identifies, organizes, plans, and allocates resources*
   1. self paced instruction with very little supervision requires time management
   2. projects require materials acquisition

B. ***Interpersonal:*** *Works with others*
   1. works well with all members of class

C. ***Information:*** *Acquires and uses information*
   1. reading assignments contain material students are responsible for which are to be obtained no where else
   2. lecture notes and research paper
   3. this is demonstrated by student's ability to complete projects

D. ***Systems:*** *Understands complex inter-relationships*
   1. program is geared toward training students to work and operate technology and system

2. as the students learn welding skills they learn to monitor and correct their own performance

E. ***Technology:*** *Works with a variety of technologies*

1. projects require selection of various technologies
2. all projects require applied technology
3. constant trouble shooting is required

II. FOUNDATION SKILLS

A. ***Basic Skills:*** *Reads, writes, performs arithmetic and mathematical operations, listens and speaks.*

1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*

a. reads and comprehends homework assignments
b. reads complicated written instruction

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*

a. creates drawings
b. creates sketches
c. creates prints with symbols, headings, notes and technical information

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*

a. converts fractions to decimals
b. converts decimals to fractions
c. adds, subtracts, multiplies and divides fractions
d. computes angles

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*

a. attends lectures
b. interprets complicated verbal instructions

5. ***Speaking:*** *Organizes ideas and communicates orally*

a. responds to oral quiz questions
b. capsulizes lecture information

B. ***Thinking Skills:*** *Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons.*

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*

a. identifies personal goals
b. identifies actions required to accomplish personal goals

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*

a. recognizes finished print from isometric drawings
b. makes daily accommodations to stay on schedule

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*

a. visualizes final part, weldment, structure from drawings

b. interprets prints with symbols, headings, notes and technical information
c. understands welding symbols

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. demonstrate mastery of basic skills
   b. recognizes information to solve specific problems
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. understands welding terminology
   b. interprets different welding techniques
   c. chooses processes to accomplish specific tasks
   d. chooses procedures to accomplish specific tasks

C. ***Personal Qualities:*** *Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty.*

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. develops good work ethic
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. achievement in class objectives
   b. attains quality results
   c. successfully completes tasks with quality results
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. working together with other students in safety
   b. working together with other students in learning
   c. assigned to group projects and assignments
4. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. accepts responsibility for own actions
   b. exhibits personal honesty at all times
   c. works with expensive tools and equipment - prompted to report all problems

*M*achine Tool *A*dvanced *S*kills
*T*echnology Program

MAST

COURSE SYLLABUS

ADVANCED SMAW AND CUTTING I

87

MAST PROGRAM
COURSE SYLLABUS
ADVANCED SMAW AND CUTTING I

Lecture hours/week: 1 **Lab hours/week: 4** **Credit hours: 3**

COURSE DESCRIPTION:

In Advanced SMAW and Cutting I the student will practice SMAW in various positions. The student will gain proficiency in oxy-fuel cutting and air carbon arc cutting and gouging. The student will also study selected technical areas related to welding. Special emphasis will be placed on weld size and AWS structural Welding Steel Code.

PREREQUISITES: **Basic Arc/Gas Welding I and II**

COURSE OBJECTIVES:

After the successful completion of this course the student will be able to:

1. The student will demonstrate a thorough knowledge of safety at all times to the instructors requirements
2. Using SMA welding equipment and E6010 the student shall weld single and multi pass T joints in 1F, 2F, 3F and 4F positions using the stringer bead technique to a Student Training Standard of 2b/B
3. Using SMA welding equipment and E6010 the student shall weld single and multi pass T joints in all positions using appropriate techniques and producing weld sizes directed by the instructor to D1.1 code requirements
4. Using air carbon arc gouging equipment the student will excavate a portion of a multi pass fillet weld as directed by the instructor and repair the excavated portion to a Student Training Standard of 2b/B
5. Using oxy-fuel cutting equipment the student shall cut straight lines, blind holes, bevels and sheet metal to a Student Training Standard of 2b/B

REQUIRED COURSE MATERIALS:

Textbook: <u>The Procedure Handbook of Arc Welding</u>, by James F. Lincoln; Arc Welding Fdn.

Supplies:

1. Safety glasses (<u>which will be worn at all times in the welding lab</u>)
2. Welder's helmet with a No. 10, 11, and 12 filter lens
3. Heavy gauntlet style welder's gloves
4. Chipping hammer
5. Wire brush
6. Pliers or vice grips
7. Appropriate clothing and shoes (no gym shoes)

8. Gas welding and cutting goggles (lens shade 5)

Special Equipment:

1. Leather sleeves or jacket. Flame retardant clothing may be substituted at the student's discretion.
2. Bastard cut ½ round file
3. Welding hat
4. Safety glasses
5. Text
6. Flashlight

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be "hands-on" activities.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments
2. apply theory to laboratory assignments
3. satisfactorily perform on written, oral, and practical examinations
4. satisfactorily perform on outside assignments including writing assignments
5. contribute to class discussions
6. maintain attendance per current policy
7. follow all shop rules and safety regulations as stated in the laboratory manual

LECTURE OUTLINE:

Lecture Topics	Text Reference Page	Contact Hrs.
Safety Review Introduction		2
Advanced Welding Techniques Inspection		1
Low Hydrogen Starts and Stops		1
Effects of Hydrogen		
Low Hydrogen Techniques		
Horizontal Welding		
Advanced Cutting Techniques		1
Vertical Welding Techniques with E6010		1
Vertical Welding Techniques with E6010		1
Vertical Welding Techniques with E6010		1
Mid-Term Exam and Practical Evaluation		

Overhead Welding with E6010	2
Visual Inspection of Welding	
Overhead Welding Techniques with E7018	2
Weld Discontinuties	
Vertical Welding Techniques with E7018	1
Defect Removal with Air Carbon Gouging	
Vertical Welding Techniques with E7018	1
Defect Removal with Air Carbon Gouging	
Overhead Welding with E7018	1
Overhead Welding with E7018	1
Oxy-Fuel Gas Beveling	1
AWS D1.1 Single V Groove 3G Qualification Practice Test	
Oxy-Fuel Gas Beveling	1
AWS D1.1 Single V Groove 3G Qualification Practice Test	
Final Exam	—
Total Lecture Hours	**18**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Advanced Welding Techniques Inspection	
Low Hydrogen Starts and Stops	
Effects of Hydrogen	
Low Hydrogen Techniques	
Horizontal Welding	
Advanced Cutting Techniques	
Vertical Welding Techniques with E6010	
Vertical Welding Techniques with E6010	
Vertical Welding Techniques with E6010	
Overhead Welding with E6010	
Visual Inspection of Welding	
Overhead Welding Techniques with E7018	
Weld Discontinuties	
Vertical Welding Techniques with E7018	
Defect Removal with Air Carbon Gouging	
Vertical Welding Techniques with E7018	
Defect Removal with Air Carbon Gouging	
Overhead Welding with E7018	
Overhead Welding with E7018	
Oxy-Fuel Gas Beveling	
AWS D1.1 Single V Groove 3G Qualification	

Oxy-Fuel Gas Beveling
AWS D1.1 Single V Groove 3G Qualification

Total Lab Hours —

COURSE OBJECTIVES: TECHNICAL COMPETENCIES

After the successful completion of this course the student will be able to:

A. FOLLOW SAFE PRACTICES

1. Wear Personal Protective Equipment
   - a. List personal protective equipment for shielded metal arc welding
   - b. List personal protective equipment for gas tungsten arc welding
   - c. List personal protective equipment for gas metal arc welding
   - d. List personal protective equipment for flux cored arc welding
   - e. List personal protective equipment for submerged arc welding
   - f. List personal protective equipment for oxy-fuel cutting
   - g. List personal protective equipment for plasma arc cutting
   - h. List personal protective equipment for air carbon arc gouging
   - i. During shop work, wear applicable personal protective equipment at all times
2. Identify Safety Rules
   - a. List environmental safety precautions i.e. fume control, radiation reflection, electrical consideration, fire hazards and control, etc.
   - b. List equipment safety rules, i.e., ventilation, grounding, duty cycle
   - c. Utilize safety when handling and storing compressed gas cylinders
   - d. List general shop safety rules
   - e. Maintain safe conditions in workstation. Student demonstrate by setting up safe workstation.
   - f. Comply with confined space entry safety procedures
   - g. Conduct a safety inspection of the student work area
   - h. Conduct a safety inspection of the welding shop
   - i. Conduct a safety inspection of the gas storage area
3. Familiarize Oneself With Safety at Facility
   - a. Attend safety tour of welding lab
   - b. Receive a safety orientation lecture
   - c. Avoid fumes through proper ventilation and good practices
   - d. Operate exhaust system
   - e. Practice electric safety with respect to welding
   - f. Protection from radiation with an understanding of personal safety equipment and conduct
   - g. Demonstrate a knowledge of fire prevention and protection for welding in dress and conduct
   - h. List welding and cutting safety rules
   - i. Demonstrate oxy-fuel gas cutting safety
   - j. Demonstrate arc welding safety

B. DEMONSTRATE TECHNICAL COMMUNICATION

1. Use Standard American Welding Standard Society Welding Terms and Definitions
   - a. Follow verbal instructions

b. Follow written details
c. Prepare time and job cards (reports & records)

C. BASIC SHIELDED METAL ARC WELDING (SMAW) AND OXY-FUEL GAS CUTTING

1. Weld Using Large Diameter SMA Electrodes
   a. Set up SMAW equipment for use with 3/16" and E7018
   b. Tack up a T joint using ½" steel
   c. Set amperage from 180 to 200 DC amps
   d. Begin the weld with a low hydrogen start by using a 75° lead angle (To fight arc blow)
   e. Bring lead angle back to normal as the weld progresses 2" along joint
   f. Begin changing the lead angle to a push or forehand angle of 70° to 80° 3" from the end of joint
   g. Make multi-pass fillet welds with smooth contour
   h. Visually inspect to insure

D. ADVANCED SHIELDED METAL ARC WELDING (SMAW) AND CUTTING

1. Weld Single V Groove Welds With Open Roots From One Side
   a. Bevel 3/8" steel plate to 37 1/2° using oxy-fuel gas cutting eg.
   b. Use grinder to remove oxide larger and smooth plate
   c. Use grinder to create root face of 3/32" to 1/8"
   d. Tack single V groove joint with 3/32" root opening
   e. Place joint in the 1G position
   f. Place joint in 2G position once task is mastered
   g. Place joint in 3G position once task is mastered
   h. Place joint in 4G position once task is mastered
   i. Weld the root with Direct Current Electrode Positive using 1/8" E6010. Use tight arc length and keyhole technique to produce a well fused root bead extending 1/16" above the plate.
   j. Weld chipped side slag and the root bead is wire brushed
   k. Fill the balance of the groove with 3/32", 1/8" and/or 5/32" E7018 using the stringer bead technique
   l. Visual test finished weld and root face bends evaluated to AWS D1.1 criteria
2. Weld Various Diameters of Pipe to Plate
   a. Inspect area for safety
   b. Place plate flat on welding table
   c. Place 3" pipe vertically on top of plate and tacked in place
   d. Leave weld coupon in the 2F fixed position
   e. Apply a 3/8" fillet weld using 1/8" E7018 and a stringer bead technique
   f. Visually inspect weld to AWS D1.1
   g. Fill pipe with water for 24 hours
   h. Check for leak
3. Produce SMAW Pipe - 5G Position
   a. Measure the pipe
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"

f. Tack the single V groove pipe joint with a 3/32" root opening
g. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
h. Chip slag and wire brush weld
i. Grind any lack of fusion and/or high spots
j. Weld the balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
k. Visually inspect weld on the root and face sides to ASME Section 9
l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

4. Produce SMAW - 2G Position Groove Welds
a. Measure the pipe
b. Mark the cut line with a wrap around and soapstone
c. Cut the bevel using oxy-fuel gas equipment
d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
e. Use the grinder to add a root face of from 3/32" to 1/8"
f. Tack the single V groove pipe joint with a 3/32" root opening
g. Weld pipe joint
h. Place the joint in the 2G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
j. Weld balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
k. Visually inspect weld on the root and face sides to ASME Section 9
l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

5. Roll Weld Pipe - SMAW
a. Measure the pipe
b. Mark the cut line with a wrap around and soapstone
c. Cut the bevel using oxy-fuel gas equipment
d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
e. Use the grinder to add a root face of from 3/32" to 1/8"
f. Tack the single V groove pipe joint with a 3/32" root opening
g. Roll weld pipe
h. Place pipe coupon on workbench in the 1G roll welding position.
i. Weld the root bead using 1/8" E6010 and the keyhole technique. The weld is performed in the 2:00 to 12:30 position
j. Chip slag and wire brush. Grind any lack of fusion and/or high spots
k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
l. Visually inspect weld on the root and face sides to ASME Section 9

m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

6. Produce SMAW Pipe - 5G Position
   a. Measure the pipe and
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Weld pipe
   g. Tack the single V groove pipe joint with a 3/32" root opening
   h. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique
   i. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   j. Chip slag and wire brush. Grind any lack of fusion and/or high spots
   k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
   l. Visually inspect weld on the root and face sides to ASME Section 9
   m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

7. Produce SMAW Pipe - 6G Position
   a. Measure the pipe
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Tack the single V groove pipe joint with a 3/32" root opening
   g. Place the joint in the 6G fixed position, using an 1/8" E6010 and a keyhole technique
   h. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
   j. Weld balance of groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
   k. Visually inspect weld on the root and face sides to ASME Section 9
   l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

8. Create SMAW Pipe to ASME Section 9
   a. Bevel two pieces of pipe to 30° bevel angle using oxy-fuel gas cutting equipment
   b. Clean bevel face and a 3/32" root face is applied using a hand held grinder
   c. Set welding condition to weld open roots

d. Tack pipe nipples together to form a V groove with a 1/8" root opening
e. Place pipe in the 5G fixed position. The root pass is welded and cleaned by wire brushing
f. Weld balance of the V groove with this procedure
g. Visual inspection is made and evaluated by ASME Section 9
h. Make four bend samples and evaluate by ASME Section 9

9. Interpret Welding Procedures
   a. Identify process
   b. Name joint design
   c. List base material
   d. Give dimensions for root treatment
   e. Name electrode size and type being used
   f. List filler material (if required), classification and specification
   g. Identify shielding gas - type and mixture
   h. List pre and post heat and interpass temperature
   i. Describe initial and interpass cleaning
   j. Describe technique which is used
   k. Produce single or multiple pass weld
   l. Choose current type
   m. Set current amperage
   n. Set current polarity
   o. Set voltage

E. QUALITY INSPECTIONS

1. Perform Visual Checks
   a. Identify common welding defects
   b. List terms for common welding defects
   c. Rate common welding defects in order of severity
   d. Name size of limitations for defects given under various codes

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U. S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance.

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

A. ***Resources:*** *Identifies, organizes, plans, and allocates resources*
   1. self paced instruction with very little supervision requires time management
   2. projects require materials acquisition

B. ***Interpersonal:*** *Works with others*

1. lab and class requires team work and cooperation to complete projects
2. safety requires mutual cooperation, vigilance and communication

C. ***Information:*** *Acquires and uses information*
1. reading assignments contain material students are responsible for which are to be obtained no where else
2. lecture notes and research paper
3. this is demonstrated by student's ability to complete projects

D. ***Systems:*** *Understands complex inter-relationships*
1. program is geared toward training students to work and operate technology and system
2. as the students learn welding skills they learn to monitor and correct their own performance

E. ***Technology:*** *Works with a variety of technologies*
1. projects require selection of various technologies
2. all projects require applied technology
3. constant trouble shooting is required

II. FOUNDATION SKILLS

A. ***Basic Skills:*** *Reads, writes, performs arithmetic and mathematical operations, listens and speaks.*

1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
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b. reads complicated written instruction

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a. completes written assignments and reports
b. completes written essay questions

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
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b. converts decimals to fractions
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d. computes angles

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
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5. ***Speaking:*** *Organizes ideas and communicates orally*
a. responds to oral quiz questions
b. capsulizes lecture information

B. ***Thinking Skills:*** *Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons.*

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
a. identifies personal goals

b. identifies actions required to accomplish personal goals

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. answer assigned questions
   b. makes daily accommodations to stay on schedule
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. understands both written and verbal instructions
   b. understands step by step procedure to produce given tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. tasks require individualized practice to develop learning skills
   b. recognizes information to solve specific problems
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. understands welding terminology
   b. interprets different welding techniques
   c. chooses processes to accomplish specific tasks
   d. chooses procedures to accomplish specific tasks

C. ***Personal Qualities:*** *Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty.*

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. develops good work ethic
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. achievement in class objectives
   b. ability to learn very challenging tasks
   c. successfully completes tasks with quality results
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. working together with other students in safety
   b. working together with other students in learning
   c. assigned to group projects and assignments
4. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. accepts responsibility for own actions
   b. exhibits personal honesty at all times
   c. works with expensive tools and equipment - prompted to report all problems

*M*achine Tool *A*dvanced *S*kills
*T*echnology Program

MAST

COURSE SYLLABUS

ADVANCED SMAW AND CUTTING II

MAST PROGRAM
COURSE SYLLABUS
ADVANCED SMAW AND CUTTING II

Lecture hours/week: 1 **Lab hours/week: 4** **Credit hours: 3**

COURSE DESCRIPTION:

In this nine week course, the student will advance his technique in out of position shielded metal arc welding. Welding of transitional joints and open groove welds will be stressed. Safety is our primary concern.

PREREQUISITES: **Basic Arc/Gas Welding I and II**

COURSE OBJECTIVES:

After the successful completion of this course the student will be able to:

1. Weld Single V Groove welds with backing 1G, 2G, 3G and 4G positions to AWS D1.1
2. Weld Single V Groove welds with open roots in the 1G, 2G, 3G and 4G positions to ASME IX
3. Using Air Carbon Arc Gouging back gouge the above groove weld
4. Extra credit welds as directed by the instructor

Oxy-Fuel Gas Cutting Manual

1. Cut steel to given size + 1/16 - 0
2. Bevel steel to given angle

REQUIRED COURSE MATERIALS:

Textbook: **Procedure Handbook of Arc Welding**, by The Lincoln Electric Co.

Supplies:

1. Safety glasses (**which will be worn at all times in the welding lab**)
2. Welder's helmet with Nos. 10, 11 and 12 filter lens
3. Heavy gauntlet style welder's gloves
4. Chipping hammer
5. Wire brush
6. Pliers or vice grips
7. Appropriate clothing and shoes
8. Gas welding and cutting goggles (lens shade 5)

Special Equipment:

1. Leather sleeves or jacket. Flame retardant clothing may be substituted at the student's discretion

2. Bastard cut ½ round file
3. Welding hat
4. Safety glasses
5. Text
6. Flashlight

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be "hands-on" activities.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments
2. apply theory to laboratory assignments
3. satisfactorily perform on written, oral, and practical examinations
4. satisfactorily perform on outside assignments including writing assignments
5. contribute to class discussions
6. maintain attendance per current policy
7. follow all shop rules and safety regulations as stated in the laboratory manual

LECTURE OUTLINE:

Lecture Topics	Text Reference Page	Contact Hrs.
Safety Review	Pages 13.3, 4; 13.5-4; 15.1-1---5	2
Special Protective Clothing	Pages 15.1-2	
Welding Containers	Pages 15.1-3	2
Abrasion	Pages 13.7-19, 20	
Weld Quality	Pages 11.1-3	1
Appearance, Weld	Pages 6.2-17, 18; 9.4-3, 8	2
Distortion Cause and Cure	Pages 3.1-1---4	1
Cause of Cracking	Pages 2.5-5, 3.1-4---19	2
Carbon Equivalent		2
SMAW Process	Pages 5.1-1---4	1
Fast Freeze	Pages 5.5-2---4; 6.2-1; 6.2-7, 8	1
Fill Freeze Fast Fill	Pages 5.5-2---4; 6.2-1	1
Low Hydrogen	Pages 6.2-10, 11; 12	1
Arc Blow	Pages 3.2-1---3	1
Porosity, Weld Spatter, Undercut, Joint Restraint	Pages 6.2-13, 18, 19	1
Review for Final Exam		
Final Exam		
	Total Lecture Hours	**18**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Weld single V groove welds with backing 1G, 2G, 3G and 4G positions Weld single V groove welds with open roots in the 1G, 2G, 3G and 4G positions Using Air Carbon Arc Gouging, back gouge the above groove welds Cut steel to given size + 1/16 - 0 Bevel steel to given angle	—
Total Lab Hours	

COURSE OBJECTIVES: TECHNICAL COMPETENCIES

After the successful completion of this course the student will be able to:

A. FOLLOW SAFE PRACTICES

1. Wear Personal Protective Equipment
   - a. List personal protective equipment for shielded metal arc welding
   - b. List personal protective equipment for gas tungsten arc welding
   - c. List personal protective equipment for gas metal arc welding
   - d. List personal protective equipment for flux cored arc welding
   - e. List personal protective equipment for submerged arc welding
   - f. List personal protective equipment for oxy-fuel cutting
   - g. List personal protective equipment for plasma arc cutting
   - h. List personal protective equipment for air carbon arc gouging
   - i. During shop work, wear applicable personal protective equipment at all times
2. Identify Safety Rules
   - a. List environmental safety precautions i.e. fume control, radiation reflection, electrical consideration, fire hazards and control, etc.
   - b. List equipment safety rules, i.e., ventilation, grounding, duty cycle
   - c. Utilize safety when handling and storing compressed gas cylinders
   - d. List general shop safety rules
   - e. Maintain safe conditions in workstation. Student demonstrate by setting up safe workstation.
   - f. Comply with confined space entry safety procedures
   - g. Conduct a safety inspection of the student work area
   - h. Conduct a safety inspection of the welding shop
   - i. Conduct a safety inspection of the gas storage area
3. Familiarize Oneself With Safety at Facility
   - a. Attend safety tour of welding lab
   - b. Receive a safety orientation lecture
   - c. Avoid fumes through proper ventilation and good practices
   - d. Operate exhaust system
   - e. Practice electric safety with respect to welding

f. Protection from radiation with an understanding of personal safety equipment and conduct
g. Demonstrate a knowledge of fire prevention and protection for welding in dress and conduct
h. List welding and cutting safety rules
i. Demonstrate oxy-fuel gas cutting safety
j. Demonstrate arc welding safety

B. DEMONSTRATE TECHNICAL COMMUNICATION

1. Use Standard American Welding Standard Society Welding Terms and Definitions
   a. Follow verbal instructions
   b. Follow written details
   c. Prepare time and job cards (reports & records)

C. ADVANCED SHIELDED METAL ARC WELDING (SMAW) AND CUTTING

1. Weld Single V Groove Welds With Open Roots From One Side
   a. Bevel 3/8" steel plate to 37 1/2° using oxy-fuel gas cutting eg.
   b. Use grinder to remove oxide larger and smooth plate
   c. Use grinder to create root face of 3/32" to 1/8"
   d. Tack single V groove joint with 3/32" root opening
   e. Place joint in the 1G position
   f. Place joint in 2G position once task is mastered
   g. Place joint in 3G position once task is mastered
   h. Place joint in 4G position once task is mastered
   i. Weld the root with Direct Current Electrode Positive using 1/8" E6010. Use tight arc length and keyhole technique to produce a well fused root bead extending 1/16" above the plate.
   j. Weld chipped side slag and the root bead is wire brushed
   k. Fill the balance of the groove with 3/32", 1/8" and/or 5/32" E7018 using the stringer bead technique
   l. Visual test finished weld and root face bends evaluated to AWS D1.1 criteria
2. Weld Various Diameters of Pipe to Plate
   a. Inspect area for safety
   b. Place plate flat on welding table
   c. Place 3" pipe vertically on top of plate and tacked in place
   d. Leave weld coupon in the 2F fixed position
   e. Apply a 3/8" fillet weld using 1/8" E7018 and a stringer bead technique
   f. Visually inspect weld to AWS D1.1
   g. Fill pipe with water for 24 hours
   h. Check for leak

D. MAINTAIN HOUSEKEEPING

1. Clean Work Area and Insure That No Safety Hazards Exist
   a. Sweep table top and floor in work area
   b. Clean equipment and tools
   c. Return tools to proper storage area
   d. Dispose of waste materials and scrap in their proper receptacle containers and storage areas
   e. Store all unused materials to their respective storage areas

E. **QUALITY INSPECTIONS**

1. Perform Visual Checks
   a. Identify common welding defects
   b. List terms for common welding defects
   c. Rate common welding defects in order of severity
   d. Name size of limitations for defects given under various codes

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U. S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance.

The following activities will be performed by each student for successful completion of this course:

I. **COMPETENCIES**

A. ***Resources:*** *Identifies, organizes, plans, and allocates resources*
   1. self paced instruction with very little supervision requires time management
   2. projects require materials acquisition

B. ***Interpersonal:*** *Works with others*
   1. lab and class requires team work and cooperation to complete projects
   2. safety requires mutual cooperation, vigilance and communication

C. ***Information:*** *Acquires and uses information*
   1. reading assignments contain material students are responsible for which are to be obtained no where else
   2. lecture notes and research paper
   3. this is demonstrated by student's ability to complete projects

D. ***Systems:*** *Understands complex inter-relationships*
   1. program is geared toward training students to work and operate technology and system
   2. as the students learn welding skills they learn to monitor and correct their own performance

E. ***Technology:*** *Works with a variety of technologies*
   1. projects require selection of various technologies
   2. all projects require applied technology
   3. constant trouble shooting is required

II. **FOUNDATION SKILLS**

A. ***Basic Skills:*** *Reads, writes, performs arithmetic and mathematical operations, listens and speaks.*

1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
   a. reads and comprehends homework assignments
   b. reads complicated written instruction
2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
   a. completes written assignments and reports
   b. completes written essay questions
3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. converts fractions to decimals
   b. converts decimals to fractions
   c. adds, subtracts, multiplies and divides fractions
   d. computes angles
4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. attends lectures
   b. interprets complicated verbal instructions
5. ***Speaking:*** *Organizes ideas and communicates orally*
   a. responds to oral quiz questions
   b. capsulizes lecture information

B. ***Thinking Skills:*** *Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons.*
1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   a. identifies personal goals
   b. identifies actions required to accomplish personal goals
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. answer assigned questions
   b. makes daily accommodations to stay on schedule
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. understands both written and verbal instructions
   b. understands step by step procedure to produce given tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. tasks require individualized practice to develop learning skills
   b. recognizes information to solve specific problems
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. understands welding terminology
   b. interprets different welding techniques
   c. chooses processes to accomplish specific tasks
   d. chooses procedures to accomplish specific tasks

C. ***Personal Qualities:*** *Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty.*

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. develops good work ethic
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. achievement in class objectives
   b. ability to learn very challenging tasks
   c. successfully completes tasks with quality results
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. working together with other students in safety
   b. working together with other students in learning
   c. assigned to group projects and assignments
4. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. accepts responsibility for own actions
   b. exhibits personal honesty at all times
   c. works with expensive tools and equipment - prompted to report all problems

*M*achine Tool *A*dvanced *S*kills
*T*echnology Program

MAST

COURSE SYLLABUS

MIG, TIG AND BRAZING I

MAST PROGRAM
COURSE SYLLABUS
MIG, TIG AND BRAZING I

Lecture hours/week: 1 **Lab hours/week: 4** **Credit hours: 3**

COURSE DESCRIPTION:

Welding, braze welding and brazing of various joints using GTAW, GMAW, FCAW, SAW and OFW.

PREREQUISITES: **Basic Arc/Gas Welding I and II**

COURSE OBJECTIVES:

After the successful completion of this course the student will be able to:

1. Given lecture/discussion and demonstration of braze welding, the student will braze weld a square groove joint in 1/8" steel to a 2b/A Training Standard
2. Given lecture/discussion and demonstration, the student will braze weld a corn cob project on 3" standard wall carbon steel pipe to a 2b/A Training Standard
3. Given lecture/discussion and demonstration on brazing (hard solder) the student will braze a lap joint in 1/8" steel to a 1a/A Training Standard
4. Given lecture/discussion and demonstration on GTAW, the student will assemble a GTAW torch to within given specs
5. Given lecture/discussion and demonstration on GTAW, the student will weld a square groove in 1/8" steel to a 2b/A Training Standard
6. Given lecture/discussion and demonstration on GTAW, the student will weld a square groove in aluminum to a 2b/A Training Standard
7. Given lecture/discussion and demonstration on GTAW, the student will weld a square groove in 1/8" stainless steel to a 2b/A Training Standard
8. Given lecture/discussion and demonstration GTAW, the student will weld a T joint to a 2b/A Training Standard
9. Given lecture/discussion and demonstration on GMAW, the student will assemble a GMAW gun to within given specs
10. Given lecture/discussion and demonstration on GMAW, the student will weld a square groove of 1/8" carbon steel to a 2b/A Training Standard
11. Given lecture/discussion and demonstration on GMAW, the student will weld a T joint 1/8" to a 3c/B Training Standard
12. Given lecture/discussion and demonstration on GMAW, the student will weld a square groove of 1/4" carbon steel to a 2b/A Training Standard
13. Given lecture/discussion and demonstration on GMAW, the student will weld a T joint 1/4" carbon steel to a 2b/A Standard Training

14. Given lecture/discussion and demonstration on FCAW, the student will weld groove a weld of 1/4" carbon steel to a 2b/A Training Standard
15. Given lecture/discussion and demonstration on FCAW, the student will weld a 3/8 fillet on ½" carbon steel to a 2b/A Training Standard
16. Given lecture/discussion and demonstration on SAW, the student will weld a T joint to within given specs

REQUIRED COURSE MATERIALS:

Textbook: **Welding Processes & Power Sources**, by Ed Pierre

Supplies:

1. Safety glasses - which will be worn at all times in the welding lab
2. Welders hood with a No. 10, 11 and 12 filter lens
3. Heavy gauntlet style welder's gloves
4. Chipping hammer
5. Wire brush
6. Pliers or vice grips
7. Appropriate clothing and shoes (no gym shoes)
8. Gas welding and cutting goggles (lens shade 5)

Special Equipment:

1. Leather sleeves or jacket. Flame retardant clothing may be substituted at the student's discretion.
2. Bastard cut ½ round file
3. Welding hat
4. Text
5. Safety glasses
6. Flashlight

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be "hands-on" activities.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments
2. apply theory to laboratory assignments
3. satisfactorily perform on written, oral, and practical examinations
4. satisfactorily perform on outside assignments including writing assignments
5. contribute to class discussions
6. maintain attendance per current policy
7. follow all shop rules and safety regulations as stated in the laboratory manual

LECTURE OUTLINE:

Lecture Topics	Text Reference Page	Contact Hrs.
Braze weld a square groove joint		1
Braze weld a corn cob project		1
Braze a lap joint in 1/8"		1
Assemble a GTAW torch and name parts		1
Weld a square groove with GTAW in 1/8" steel		1
Weld a square groove in aluminum with GTAW to a 2b/A		1
Weld a square groove in 1/8" stainless steel with GTAW		1
Weld a T joint to a 2b/A Training Standard stainless steel with GTAW		1
Weld a T joint to a 2b/A Training Standard carbon steel with GTAW		1
Weld a T joint to a 2b/A Training Standard Aluminum with GTAW		1
Assemble a GMAW gun		1
Weld a square groove of 1/8" carbon steel with GMAW		1
Weld a T joint 1/8" with GTAW		1
Weld a square groove of 1/4" carbon steel with GMAW		1
Weld a T joint 1/4" carbon steel with GMAW		1
Weld groove a weld of 1/4" carbon steel with FACW		1
Weld a 3/8 fillet on ½" carbon steel with FCAW		1
Weld a T joint on carbon steel with SAW		1
	Total Lecture Hours	**18**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Braze weld a square groove joint in 1/8" steel	
Braze weld a corn cob project on 3" standard wall carbon steel pipe	
Braze a lap joint in 1/8" steel	
Assemble a GTAW torch to within given specs	
Weld a square groove with GTAW in 1/8" steel	

Weld a square groove in aluminum with GTAW
Weld a square groove in 1/8" stainless steel with GTAW
Weld a T joint with GTAW in stainless steel
Weld a T joint with GTAW in carbon steel
Weld a T joint with GTAW in aluminum
Assemble a GMAW gun to within given specs
Weld a square groove of 1/8" carbon steel with GMAW
Weld a T joint in 1/8" with GMAW
Weld a square groove of 1/4" carbon steel with GMAW
Weld a T joint of 1/4" carbon steel with GMAW
Weld groove a weld of 1/4" carbon steel with FACW
Weld a 3/8 fillet on ½" carbon steel with FCAW
Weld a T joint on carbon steel with SAW

Total Lab Hours —

COURSE OBJECTIVES: TECHNICAL COMPETENCIES

After the successful completion of this course the student will be able to:

A. FOLLOW SAFE PRACTICES

1. Wear Personal Protective Equipment
   a. List personal protective equipment for shielded metal arc welding
   b. List personal protective equipment for gas tungsten arc welding
   c. List personal protective equipment for gas metal arc welding
   d. List personal protective equipment for flux cored arc welding
   e. List personal protective equipment for submerged arc welding
   f. List personal protective equipment for oxy-fuel cutting
   g. List personal protective equipment for plasma arc cutting
   h. List personal protective equipment for air carbon arc gouging
   i. During shop work, wear applicable personal protective equipment at all times
2. Identify Safety Rules
   a. List environmental safety precautions i.e. fume control, radiation reflection, electrical consideration, fire hazards and control, etc.
   b. List equipment safety rules, i.e., ventilation, grounding, duty cycle
   c. Utilize safety when handling and storing compressed gas cylinders
   d. List general shop safety rules
   e. Maintain safe conditions in workstation. Student demonstrate by setting up safe workstation.
   f. Comply with confined space entry safety procedures
   g. Conduct a safety inspection of the student work area
   h. Conduct a safety inspection of the welding shop
   i. Conduct a safety inspection of the gas storage area
3. Familiarize Oneself With Safety at Facility

a. Attend safety tour of welding lab
b. Receive a safety orientation lecture
c. Avoid fumes through proper ventilation and good practices
d. Operate exhaust system
e. Practice electric safety with respect to welding
f. Protection from radiation with an understanding of personal safety equipment and conduct
g. Demonstrate a knowledge of fire prevention and protection for welding in dress and conduct
h. List welding and cutting safety rules
i. Demonstrate oxy-fuel gas cutting safety
j. Demonstrate arc welding safety

B. DEMONSTRATE TECHNICAL COMMUNICATION

1. Use Standard American Welding Standard Society Welding Terms and Definitions
   a. Follow verbal instructions
   b. Follow written details
   c. Prepare time and job cards (reports & records)

C. GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
   a. Install adapter for particular brand of wire feeder
   b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
   c. Screw on gas defuser and tighten allen screw
   d. Install contact tip
   e. Install gas nozzle
   f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
   a. Compare and contrast constant current and constant voltage power sources
   b. List effects of inductance on circuit
   c. List effects of pinch effect
3. Shielding Gas Application
   a. List arc characteristics caused by welding with 100% carbon dioxide
   b. List arc characteristics caused by welding with 100% argon
   c. List arc characteristics caused by welding with 75% Argon and 25% CO2
   d. List arc characteristics caused by welding with 95% Argon and 5% CO2
   e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness

b. Choose the correct electrode for given material and applications both type and size
c. Set voltage and wire feed speed for a given application, material and material thickness

6. Weld With GMAW Using Globular Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness
7. Weld T Joints on Carbon Steel Using GMAW Equipment
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Tack a T joint using GMAW
   e. Weld 1/4" fillet welds in 2F position using string bead technique
   f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
   g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
8. Weld Single V Groove With GMAW
   a. Inspect the work area and equipment for safety
   b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
   c. Use grind to clean the bevel face and apply a 3/32" root face
   d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
   e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
   f. Weld root upwards
   g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
   h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
   i. Complete the second pass using GMAW and upward Z weave technique
   j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
   k. Make fourth and final pass with the same technique.
   l. The electrode is weaved from one bevel edge to another
   m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges

D. GAS TUNGSTEN ARC WELDING (GTAW)

1. Weld Fillet - 2F Horizontal Position
   a. Conduct safety inspection of the area and equipment
   b. Weld on 304 stainless steel
   c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
   d. Cut stainless steel to .050" X 2" X 10"
   e. Fit up and tack a T joint and place in the 2F position
   f. Weld a .050" fillet weld using .045" ER308-L
   g. Visually inspect joint for burn through, weld size and workmanship
2. Weld on 1/8" Material and 100% Penetration
   a. Conduct safety inspection of the area and equipment
   b. Weld on 304 stainless steel
   c. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
   d. Cut stainless steel and grind a .30" bevel on edges
   e. Place two pieces of stainless steel in the backing purge in the 1G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
   f. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
   g. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver.
3. Weld 2G Position Using GTAW
   a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
   b. Cut stainless steel and grind a .30" bevel on edges
   c. Place two pieces of stainless steel in the backing purge in the 2G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
   d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
   e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver

E. MAINTAIN HOUSEKEEPING

1. Clean Work Area and Insure That No Safety Hazards Exist
   a. Sweep table top and floor in work area
   b. Clean equipment and tools
   c. Return tools to proper storage area
   d. Dispose of waste materials and scrap in their proper receptacle containers and storage areas
   e. Store all unused materials to their respective storage areas

COURSE OBJECTIVES: SCANS COMPETENCIES

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D. ***Systems:*** *Understands complex inter-relationships*

1. program is geared toward training students to work and operate technology and system
2. as the students learn welding skills they learn to monitor and correct their own performance

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2. all projects require applied technology
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II. FOUNDATION SKILLS

A. ***Basic Skills:*** *Reads, writes, performs arithmetic and mathematical operations, listens and speaks.*

1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*

a. reads and comprehends homework assignments
b. reads complicated written instruction

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*

a. completes written assignments and reports

b. completes written essay questions

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. converts fractions to decimals
   b. converts decimals to fractions
   c. adds, subtracts, multiplies and divides fractions
   d. computes angles
4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. attends lectures
   b. interprets complicated verbal instructions
5. ***Speaking:*** *Organizes ideas and communicates orally*
   a. responds to oral quiz questions
   b. capsulizes lecture information

B. ***Thinking Skills:*** *Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons.*
1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   a. identifies personal goals
   b. identifies actions required to accomplish personal goals
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. answer assigned questions
   b. makes daily accommodations to stay on schedule
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. understands both written and verbal instructions
   b. understands step by step procedure to produce given tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. tasks require individualized practice to develop learning skills
   b. recognizes information to solve specific problems
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. understands welding terminology
   b. interprets different welding techniques
   c. chooses processes to accomplish specific tasks
   d. chooses procedures to accomplish specific tasks

C. ***Personal Qualities:*** *Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty.*
1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. develops good work ethic
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. achievement in class objectives

b. ability to learn very challenging tasks
c. successfully completes tasks with quality results

3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. working together with other students in safety
   b. working together with other students in learning
   c. assigned to group projects and assignments
4. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. accepts responsibility for own actions
   b. exhibits personal honesty at all times
   c. works with expensive tools and equipment - prompted to report all problems

*M*achine Tool *A*dvanced *S*kills
*T*echnology Program

MAST

COURSE SYLLABUS

MIG, TIG AND BRAZING II

MAST PROGRAM
COURSE SYLLABUS
MIG, TIG AND BRAZING II

Lecture hours/week: 1 **Lab hours/week: 4** **Credit hours: 3**

COURSE DESCRIPTION:

Position welding brazing various joints using GTAW, GMAW, FCAW, SAW, and oxy/fuel.

PREREQUISITES: **Basic Arc/Gas Welding I and II; MIG, TIG and Brazing I**

COURSE OBJECTIVES:

After the successful completion of this course the student will be able to:

1. Given lecture/discussion on braze welding butt joints, student will set up and braze weld a lap joint to a 1G, 2G, 3G & 4G positions to a "2b/A" Training Standard
2. Given lecture/discussion on braze welding T joints, student will set up and braze weld a T joint in 1F, 2F, 3F & 4F positions to a "2b/A" Training Standard
3. Given lecture/discussion on brazing T joint, student will set up and braze T joints to a "2b/A" Training Standard
4. Given lecture/discussion on soldering T joints, student will set up and soft solder tee joints to a "2b/A" Training Standard
5. Given lecture/discussion in GTAW T joint, student will set up and weld T joints in carbon steel, stainless steel and aluminum in 2F, 3F & 4F positions to a "2b/A" Training Standard
6. Given lecture/discussion in GTAW grooves, student will set up and weld grooves in carbon steel, stainless steel and aluminum in 1G, 3G & 4G positions to a "2b/A" Training Standard
7. Given lecture/discussion in FCAW T joint, student will set up and weld edge joints in carbon steel in 2F, 3F & 4F positions to a "2b/A" Training Standard
8. Given lecture/discussion in GMAW fillet weld, student will set up and GMAW fillet welds in mild steel to a "2 b/A" Training Standards
9. Given lecture/discussion in GMAW butt joint, student will set up and GMAW butt joints in mile steel to a "2b/A" Training Standards

REQUIRED COURSE MATERIALS:

Textbook: Welding Processes and Power Sources, by Edward Pierre

Supplies:

1. Safety glasses - which will be worn at all times in the welding lab
2. Welders hood with a No. 10, 11 and 12 filter lens
3. Heavy gauntlet style welder's gloves

4. Chipping hammer
5. Wire brush
6. Pliers or vice grips
7. Appropriate clothing and shoes (no gym shoes)
8. Gas welding and cutting goggles (lens shade 5)

Special Equipment:

1. Leather sleeves or jacket. Flame retardant clothing may be substituted at the student's discretion.
2. Bastard cut ½ round file
3. Welding hat
4. Text
5. Safety glasses
6. Flashlight

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be "hands-on" activities.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments
2. apply theory to laboratory assignments
3. satisfactorily perform on written, oral, and practical examinations
4. satisfactorily perform on outside assignments including writing assignments
5. contribute to class discussions
6. maintain attendance per current policy
7. follow all shop rules and safety regulations as stated in the laboratory manual

LECTURE OUTLINE:

Lecture Topics	Text Reference Page	Contact Hrs.
Braze weld a lap joint in the 1G, 2G, 3G and 4G Positions		2
Braze weld a T joint in 1F, 2F, 3F, and 4F Positions		2
Braze T joints		2
Soft solder lab joints		2
Weld T joints in carbon steel, stainless steel and aluminum in 2F, 3F and 4F Positions with GTAW		2
Weld grooves in carbon steel, stainless steel and aluminum in 1G, 3G		

and 4F Positions with GTAW	2
Weld T joints in carbon steel in 2F, 3F and 4F Positions with FCAW	2
Weld fillet welds in mild steel in 2F, 3F and 4F Positions with GMAW	2
Weld butt joints in mild steel in 2G, 3G and 4G Positions with GMAW	2
Total Lecture Hours	**18**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Braze weld a lap joint in the 1G, 2G, 3G and 4G Positions	
Braze weld a T joint in 1F, 2F, 3F, and 4F Positions	
Braze T joints	
Soft solder lab joints	
Weld T joints in carbon steel, stainless steel and aluminum in 2F, 3F and 4F Positions with GTAW	
Weld grooves in carbon steel, stainless steel and aluminum in 1G, 3G and 4F Positions with GTAW	
Weld T joints in carbon steel in 2F, 3F and 4F Positions with FCAW	
Weld fillet welds in mild steel in 2F, 3F and 4F Positions with GMAW	
Weld butt joints in mild steel in 2G, 3G and 4G Positions with GMAW	—
Total Lab Hours	

COURSE OBJECTIVES: TECHNICAL COMPETENCIES

After the successful completion of this course the student will be able to:

A. FOLLOW SAFE PRACTICES

1. Wear Personal Protective Equipment
   - a. List personal protective equipment for shielded metal arc welding
   - b. List personal protective equipment for gas tungsten arc welding
   - c. List personal protective equipment for gas metal arc welding
   - d. List personal protective equipment for flux cored arc welding
   - e. List personal protective equipment for submerged arc welding
   - f. List personal protective equipment for oxy-fuel cutting
   - g. List personal protective equipment for plasma arc cutting
   - h. List personal protective equipment for air carbon arc gouging
   - i. During shop work, wear applicable personal protective equipment at all times
2. Identify Safety Rules

a. List environmental safety precautions i.e. fume control, radiation reflection, electrical consideration, fire hazards and control, etc.
b. List equipment safety rules, i.e., ventilation, grounding, duty cycle
c. Utilize safety when handling and storing compressed gas cylinders
d. List general shop safety rules
e. Maintain safe conditions in workstation. Student demonstrate by setting up safe workstation.
f. Comply with confined space entry safety procedures
g. Conduct a safety inspection of the student work area
h. Conduct a safety inspection of the welding shop
i. Conduct a safety inspection of the gas storage area

3. Familiarize Oneself With Safety at Facility
   a. Attend safety tour of welding lab
   b. Receive a safety orientation lecture
   c. Avoid fumes through proper ventilation and good practices
   d. Operate exhaust system
   e. Practice electric safety with respect to welding
   f. Protection from radiation with an understanding of personal safety equipment and conduct
   g. Demonstrate a knowledge of fire prevention and protection for welding in dress and conduct
   h. List welding and cutting safety rules
   i. Demonstrate oxy-fuel gas cutting safety
   j. Demonstrate arc welding safety

B. DEMONSTRATE TECHNICAL COMMUNICATION

1. Use Standard American Welding Standard Society Welding Terms and Definitions
   a. Follow verbal instructions
   b. Follow written details
   c. Prepare time and job cards (reports & records)

C. PIPE WELDING - SMAW

1. Weld Open Root Pipe - 2G Position
   a. Use 1/8" E6010
   b. Cut and ground pipe ends to single bevel edge preparations of 37 1/2° c.Fit together two pipe ends to a single V edge preparation within given tolerances
   c. Weld root pass to ASME Section 9 requirements
   d. Clean weld pass by chipping slag, wire brushing and grinding where necessary to assure a clean, well fused weld deposit
   e. Weld remainder of the groove using E7018 with the stringer bead technique

D. GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
   a. Install adapter for particular brand of wire feeder
   b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
   c. Screw on gas defuser and tighten allen screw
   d. Install contact tip

e. Install gas nozzle
f. Adjust gun for tip to work distance

2. Weld With GMAW Using Short Circuit Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness
3. Weld With GMAW Using Pulsed Spray Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness
4. Weld Multi-Pass Fillet Welds - All Positions
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Tack a T joint using GMAW
   e. Weld the second pass with electrode centered at the bottom toe of the first pass
   f. Weld the third pass with electrode centered at the top toe of the second pass
   g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
5. Weld Multi-Pass Fillet Welds - 3F Vertical Position
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique
   e. Weld the second pass with electrode centered at the bottom toe of the first pass
   f. Weld the third pass with electrode centered at the top toe of the second pass
   g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
6. Weld Multi-Pass Fillet Welds - 4F Overhead Position
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Place the T joint in the 4F overhead position approximately at eye level
   e. Weld a 1/4" fillet weld (wire brush weld after each pass)
   f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

7. Weld Pipe - 1G Position
    a. Fit up and tack pipe according to given tolerances
    b. Adjust wire feeder drive system
    c. Adjust shielding gas system and flow rate
    d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
    e. Set welding condition for spray transfer - Wire Feed Speed
    f. Set welding condition for short circuit transfer - Voltage
    g. Set welding condition for short circuit transfer - Tip to Work Distance
    h. Weld using roll welding technique

E. GAS TUNGSTEN ARC WELDING (GTAW)

1. Weld Fillet - 2F Horizontal Position
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
    d. Cut stainless steel to .050" X 2" X 10"
    e. Fit up and tack a T joint and place in the 2F position
    f. Weld a .050" fillet weld using .045" ER308-L
    g. Visually inspect joint for burn through, weld size and workmanship
2. Weld Fillet - 3F Vertical Position
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
    d. Cut stainless steel to .050" X 2" X 10"
    e. Fit up and tack a T joint and place in the 3F vertical position
    f. Weld a .050" fillet weld using .045" ER308-L
    g. Visually inspect joint for burn through, weld size and workmanship
3. Weld Fillet - 4F Overhead Position
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
    d. Cut stainless steel to .050" X 2" X 10"
    e. Fit up and tack a T joint and place in the 4F overhead position
    f. Weld a .050" fillet weld using .045" ER308-L
    g. Visually inspect joint for burn through, weld size and workmanship
4. Weld 3G Position Using GTAW
    a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    b. Cut stainless steel and grind a .30" bevel on edges

c. Place two pieces of stainless steel in the backing purge in the 3G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver

5. Weld 4G Position Using GTAW
a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
b. Cut stainless steel and grind a .30" bevel on edges
c. Place two pieces of stainless steel in the backing purge in the 4G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver.

6. Weld Pipe Open Root Passes All Positions Using GTAW
a. Fit up and tack weld pipe to within procedure tolerances. (Set up GTAW equipment for welding carbon steel)
b. Prepare tungsten for given procedure
c. Set up GTAW torch for given procedure
d. Set current for procedure
e. Adjust shielding gas flow rate
f. Weld root using free hand technique and using the walking the cup method
g. Apply second pass using weave

F. MAINTAIN HOUSEKEEPING

1. Clean Work Area and Insure That No Safety Hazards Exist
a. Sweep table top and floor in work area
b. Clean equipment and tools
c. Return tools to proper storage area
d. Dispose of waste materials and scrap in their proper receptacle containers and storage areas
e. Store all unused materials to their respective storage areas

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U. S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry.

SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance.

The following activities will be performed by each student for successful completion of this course:

I. **COMPETENCIES**

- *A.* ***Resources:*** *Identifies, organizes, plans, and allocates resources*
  1. self paced instruction with very little supervision requires time management
  2. projects require materials acquisition
- *B.* ***Interpersonal:*** *Works with others*
  1. lab and class requires team work and cooperation to complete projects
  2. safety requires mutual cooperation, vigilance and communication
- *C.* ***Information:*** *Acquires and uses information*
  1. reading assignments contain material students are responsible for which are to be obtained no where else
  2. lecture notes and research paper
  3. this is demonstrated by student's ability to complete projects
- *D.* ***Systems:*** *Understands complex inter-relationships*
  1. program is geared toward training students to work and operate technology and system
  2. as the students learn welding skills they learn to monitor and correct their own performance
- *E.* ***Technology:*** *Works with a variety of technologies*
  1. projects require selection of various technologies
  2. all projects require applied technology
  3. constant trouble shooting is required

II. **FOUNDATION SKILLS**

- *A.* ***Basic Skills:*** Reads, writes, performs arithmetic and mathematical operations, listens and speaks.
  - *1.* ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
    - a. reads and comprehends homework assignments
    - b. reads complicated written instruction
  - *2.* ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
    - a. completes written assignments and reports
    - b. completes written essay questions
  - *3.* ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
    - a. converts fractions to decimals
    - b. converts decimals to fractions
    - c. adds, subtracts, multiplies and divides fractions

d. computes angles

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. attends lectures
   b. interprets complicated verbal instructions
5. ***Speaking:*** *Organizes ideas and communicates orally*
   a. responds to oral quiz questions
   b. capsulizes lecture information

B. ***Thinking Skills:*** *Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons.*

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   a. identifies personal goals
   b. identifies actions required to accomplish personal goals
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. answer assigned questions
   b. makes daily accommodations to stay on schedule
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. understands both written and verbal instructions
   b. understands step by step procedure to produce given tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. tasks require individualized practice to develop learning skills
   b. recognizes information to solve specific problems
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. understands welding terminology
   b. interprets different welding techniques
   c. chooses processes to accomplish specific tasks
   d. chooses procedures to accomplish specific tasks

C. ***Personal Qualities:*** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty.

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. develops good work ethic
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. achievement in class objectives
   b. ability to learn very challenging tasks
   c. successfully completes tasks with quality results
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. working together with other students in safety
   b. working together with other students in learning
   c. assigned to group projects and assignments

4. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. accepts responsibility for own actions
   b. exhibits personal honesty at all times
   c. works with expensive tools and equipment - prompted to report all problems

***M**achine Tool **A**dvanced **S**kills*
***T**echnology Program*

MAST

COURSE SYLLABUS

BASIC WELDING METALLURGY

MAST PROGRAM
COURSE SYLLABUS
BASIC WELDING METALLURGY

Lecture hours/week: 2 **Lab hours/week: 2** **Credit hours: 3**

COURSE DESCRIPTION:

Students will learn about the physical and metallurgical properties of carbon steels and how welding will effect these properties.

PREREQUISITES: **NONE**

COURSE OBJECTIVES:

After the successful completion of this course the student will be able to:

1. The student will learn the meaning of selected metallurgical terms
2. The student will identify selected types of carbon steels and describe the process used in their manufacture
3. The student will demonstrate his knowledge of selected carbon steels by correctly describing their properties and how these properties are changed by welding temperatures
4. The student will describe the effect of selected alloying element on carbon steel
5. The student will identify basic concepts relating to the heat effected zone (HAZ) caused when welding different types of carbon steels
6. The student will take Macro cross sections of selected welds, etch them and inspect the weld interior and heat effected zone

REQUIRED COURSE MATERIALS:

Textbook: Welding Metallurgy, by Linnert

Supplies: None

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be "hands-on" activities.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments
2. apply theory to laboratory assignments
3. satisfactorily perform on written, oral, and practical examinations
4. satisfactorily perform on outside assignments including writing assignments
5. contribute to class discussions
6. maintain attendance per current policy
7. follow all shop rules and safety regulations as stated in the laboratory manual

LECTURE OUTLINE:

Lecture Topics	Text Reference Page	Contact Hrs.
Define selected metallurgical terms		6
Identify selected types of carbon steels and describe process used in their manufacture		6
Describe mechanical and physical properties of selected steels and describe changes caused by welding		6
Describe the effect of selected alloying elements on carbon steel		6
Identify basic concepts relating to the heat effected zone (HAZ) caused when welding different types of carbon steel		6
Make macro cross sections of selected welds, etch them and inspect the weld interior and heat effect zone		6
	Total Lecture Hours	**36**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Make macro cross sections of selected welds, etch them and inspect the weld interior and heat effect zone	—
Total Lab Hours	

COURSE OBJECTIVES: TECHNICAL COMPETENCIES

After the successful completion of this course the student will be able to:

A. FOLLOW SAFE PRACTICES

1. Wear Personal Protective Equipment
   a. List personal protective equipment for shielded metal arc welding
   b. List personal protective equipment for gas tungsten arc welding
   c. List personal protective equipment for gas metal arc welding

d. List personal protective equipment for flux cored arc welding
e. List personal protective equipment for submerged arc welding
f. List personal protective equipment for oxy-fuel cutting
g. List personal protective equipment for plasma arc cutting
h. List personal protective equipment for air carbon arc gouging
i. During shop work, wear applicable personal protective equipment at all times

2. Identify Safety Rules
   a. List environmental safety precautions i.e. fume control, radiation reflection, electrical consideration, fire hazards and control, etc.
   b. List equipment safety rules, i.e., ventilation, grounding, duty cycle
   c. Utilize safety when handling and storing compressed gas cylinders
   d. List general shop safety rules
   e. Maintain safe conditions in workstation. Student demonstrate by setting up safe workstation.
   f. Comply with confined space entry safety procedures
   g. Conduct a safety inspection of the student work area
   h. Conduct a safety inspection of the welding shop
   i. Conduct a safety inspection of the gas storage area

3. Familiarize Oneself With Safety at Facility
   a. Attend safety tour of welding lab
   b. Receive a safety orientation lecture
   c. Avoid fumes through proper ventilation and good practices
   d. Operate exhaust system
   e. Practice electric safety with respect to welding
   f. Protection from radiation with an understanding of personal safety equipment and conduct
   g. Demonstrate a knowledge of fire prevention and protection for welding in dress and conduct
   h. List welding and cutting safety rules
   i. Demonstrate oxy-fuel gas cutting safety
   j. Demonstrate arc welding safety

B. DEMONSTRATE TECHNICAL COMMUNICATION

1. Use Standard American Welding Standard Society Welding Terms and Definitions
   a. Follow verbal instructions
   b. Follow written details
   c. Prepare time and job cards (reports & records)

C. BASIC WELDING METALLURGY

1. Become Conversant With Common Metallurgical Terms
   a. Describe structure of metals
   b. Describe critical temperature
   c. Define allotropic transformation
   d. Describe eutectic point
   e. Read phase diagram
   f. Define liquidus
   g. Define solidus

h. Define annealing
i. Define normalize
j. Define heat treatment
k. Define stress relieve
l. Define delta ferrite
m. Define ferrite
n. Define austenite
o. Define pearlite
p. Define cementite
q. Define tempering

2. Describe the Properties of Various Types of Steel
   a. Define low carbon steel
   b. Define medium carbon steel
   c. Define high carbon steel
   d. Define very high carbon steel
   e. Define cast iron
   f. Define low alloy high strength
   g. Define alloy steels
   h. Define stainless steels
   i. Define non ferrous metals
3. List Various Alloys and Their Effect When Combined With Steel
   a. Draw and describe substitutional alloys
   b. Draw and describe interstitial alloys
   c. Draw and describe multi phase alloys
   d. Define harden ability
   e. Work carbon equivalent equations
4. Describe the Effect Welding Has on Properties of various Types of Carbon Steels
   a. Sketch crystal structures of metals
   b. Sketch face centered cubic
   c. Sketch body centered cubic
   d. Sketch hexagonal close packed
5. Identify Basic Concepts Relating to the Heat Affected Zone
   a. Define micro structure
   b. Define macro structure
   c. Define cold working
   d. Define elongated grain structure
   e. Define grain boundary
   f. Define grain growth
   g. Define fusion zone
   h. Define fusion interface

D. MAINTAIN HOUSEKEEPING

1. Clean Work Area and Insure That No Safety Hazards Exist
   a. Sweep table top and floor in work area
   b. Clean equipment and tools
   c. Return tools to proper storage area

d. Dispose of waste materials and scrap in their proper receptacle containers and storage areas
e. Store all unused materials to their respective storage areas

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U. S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance.

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

A. ***Resources:*** *Identifies, organizes, plans, and allocates resources*
1. self paced instruction with very little supervision requires time management
2. projects require materials acquisition

B. ***Interpersonal:*** *Works with others*
1. lab and class requires team work and cooperation to complete projects
2. safety requires mutual cooperation, vigilance and communication

C. ***Information:*** *Acquires and uses information*
1. reading assignments contain material students are responsible for which are to be obtained no where else
2. lecture notes and research paper
3. this is demonstrated by student's ability to complete projects

D. ***Systems:*** *Understands complex inter-relationships*
1. program is geared toward training students to work and operate technology and system
2. as the students learn welding skills they learn to monitor and correct their own performance

E. ***Technology:*** *Works with a variety of technologies*
1. projects require selection of various technologies
2. all projects require applied technology
3. constant trouble shooting is required

II. FOUNDATION SKILLS

A. ***Basic Skills:*** *Reads, writes, performs arithmetic and mathematical operations, listens and speaks.*

1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
a. reads and comprehends homework assignments

b. reads complicated written instruction

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
   a. completes written assignments and reports
   b. completes written essay questions
3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. converts fractions to decimals
   b. converts decimals to fractions
   c. adds, subtracts, multiplies and divides fractions
   d. computes angles
4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. attends lectures
   b. interprets complicated verbal instructions
5. ***Speaking:*** *Organizes ideas and communicates orally*
   a. responds to oral quiz questions
   b. capsulizes lecture information

B. ***Thinking Skills:*** *Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons.*

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   a. identifies personal goals
   b. identifies actions required to accomplish personal goals
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. answer assigned questions
   b. makes daily accommodations to stay on schedule
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. understands both written and verbal instructions
   b. understands step by step procedure to produce given tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. tasks require individualized practice to develop learning skills
   b. recognizes information to solve specific problems
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. understands welding terminology
   b. interprets different welding techniques
   c. chooses processes to accomplish specific tasks
   d. chooses procedures to accomplish specific tasks

C. ***Personal Qualities:*** *Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty.*

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. develops good work ethic
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. achievement in class objectives
   b. ability to learn very challenging tasks
   c. successfully completes tasks with quality results
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. working together with other students in safety
   b. working together with other students in learning
   c. assigned to group projects and assignments
4. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. accepts responsibility for own actions
   b. exhibits personal honesty at all times
   c. works with expensive tools and equipment - prompted to report all problems

*M*achine Tool *A*dvanced *S*kills
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MAST

COURSE SYLLABUS

INDIVIDUAL WELDING PROBLEMS I

MAST PROGRAM
COURSE SYLLABUS
INDIVIDUAL WELDING PROBLEMS 1

Lecture hours/week: 0 **Lab hours/week: 5** **Credit hours: 3**

COURSE DESCRIPTION:

This is a self-directed study course. In other words the student is responsible for meeting all objectives which the student will create. In this course the student will prepare a written proposal identifying specific problems to be addressed and submit it to the instructor for approval by the end of the second week of the semester. This contract must be written. This contract will state class meeting time and required written work. Upon approval, the contract will be signed by the student and the instructor. The contract will then be attached to the syllabus. Students must make arrangements with instructor prior to signing up for class.

PREREQUISITES: **Basic Arc/Gas Welding I and II**

COURSE OBJECTIVES:

After the successful completion of this course the student will be able to state the objective of the course and show evidence of completion of stated objectives.

1. Identify and define welding problems
2. Organize tasks and develop procedures for accomplishment
3. Develop independent work habits
4. Variable technical skills depending on individual problems
5. Acquire speed in work habits
6. Use safe work procedures

Major Concepts:

1. Self-direction
2. Problem solving
3. Variable technical content
4. Develop speed
5. Develop safety

REQUIRED COURSE MATERIALS:

Textbook: None. Library assignments are substituted for required text.

Supplies: Specific supplies are dictated by objective.

1. Safety glasses - which will be worn at all times in the welding lab
2. Welders hood with a No. 10, 11 and 12 filter lens
3. Heavy gauntlet style welder's gloves
4. Chipping hammer

5. Wire brush
6. Pliers or vice grips
7. Appropriate clothing and shoes
8. Gas welding and cutting goggles (lens shade 5)

METHODS OF INSTRUCTION:

Laboratory: Laboratory will be "hands-on" activities.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments
2. apply theory to laboratory assignments
3. satisfactorily perform on written, oral, and practical examinations
4. satisfactorily perform on outside assignments including writing assignments
5. contribute to class discussions
6. maintain attendance per current policy
7. follow all shop rules and safety regulations as stated in the laboratory manual

LAB OUTLINE:

Lab Topics	Contact Hrs.
Self-Directed Study	—
Total Lab Hours	**80**

COURSE OBJECTIVES: TECHNICAL COMPETENCIES

After the successful completion of this course the student will be able to:

A. FOLLOW SAFE PRACTICES

1. Wear Personal Protective Equipment
   a. List personal protective equipment for shielded metal arc welding
   b. List personal protective equipment for gas tungsten arc welding
   c. List personal protective equipment for gas metal arc welding
   d. List personal protective equipment for flux cored arc welding
   e. List personal protective equipment for submerged arc welding
   f. List personal protective equipment for oxy-fuel cutting
   g. List personal protective equipment for plasma arc cutting
   h. List personal protective equipment for air carbon arc gouging
   i. During shop work, wear applicable personal protective equipment at all times
2. Identify Safety Rules
   a. List environmental safety precautions i.e. fume control, radiation reflection, electrical consideration, fire hazards and control, etc.
   b. List equipment safety rules, i.e., ventilation, grounding, duty cycle
   c. Utilize safety when handling and storing compressed gas cylinders

d. List general shop safety rules
e. Maintain safe conditions in workstation. Student demonstrate by setting up safe workstation.
f. Comply with confined space entry safety procedures
g. Conduct a safety inspection of the student work area
h. Conduct a safety inspection of the welding shop
i. Conduct a safety inspection of the gas storage area

3. Familiarize Oneself With Safety at Facility
   a. Attend safety tour of welding lab
   b. Receive a safety orientation lecture
   c. Avoid fumes through proper ventilation and good practices
   d. Operate exhaust system
   e. Practice electric safety with respect to welding
   f. Protection from radiation with an understanding of personal safety equipment and conduct
   g. Demonstrate a knowledge of fire prevention and protection for welding in dress and conduct
   h. List welding and cutting safety rules
   i. Demonstrate oxy-fuel gas cutting safety
   j. Demonstrate arc welding safety

B. DEMONSTRATE TECHNICAL COMMUNICATION

1. Use Standard American Welding Standard Society Welding Terms and Definitions
   a. Follow verbal instructions
   b. Follow written details
   c. Prepare time and job cards (reports & records)

C. MAINTAIN HOUSEKEEPING

1. Clean Work Area and Insure That No Safety Hazards Exist
   a. Sweep table top and floor in work area
   b. Clean equipment and tools
   c. Return tools to proper storage area
   d. Dispose of waste materials and scrap in their proper receptacle containers and storage areas
   e. Store all unused materials to their respective storage areas

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U. S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance.

The following activities will be performed by each student for successful completion of this course:

I. **COMPETENCIES**

A. ***Resources:*** *Identifies, organizes, plans, and allocates resources*
   1. self paced instruction with very little supervision requires time management
   2. projects require materials acquisition

B. ***Interpersonal:*** *Works with others*
   1. lab and class requires team work and cooperation to complete projects
   2. safety requires mutual cooperation, vigilance and communication

C. ***Information:*** *Acquires and uses information*
   1. reading assignments contain material students are responsible for which are to be obtained no where else
   2. lecture notes and research paper
   3. this is demonstrated by student's ability to complete projects

D. ***Systems:*** *Understands complex inter-relationships*
   1. program is geared toward training students to work and operate technology and system
   2. as the students learn welding skills they learn to monitor and correct their own performance

E. ***Technology:*** *Works with a variety of technologies*
   1. projects require selection of various technologies
   2. all projects require applied technology
   3. constant trouble shooting is required

II. **FOUNDATION SKILLS**

A. ***Basic Skills:*** *Reads, writes, performs arithmetic and mathematical operations, listens and speaks.*
   1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
      a. reads and comprehends homework assignments
      b. reads complicated written instruction
   2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
      a. completes written assignments and reports
      b. completes written essay questions
   3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
      a. converts fractions to decimals
      b. converts decimals to fractions
      c. adds, subtracts, multiplies and divides fractions
      d. computes angles
   4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
      a. interprets complicated verbal instructions
   5. ***Speaking:*** *Organizes ideas and communicates orally*
      a. responds to oral quiz questions
      b. capsulizes lecture information

B. ***Thinking Skills:*** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons.

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   a. identifies personal goals
   b. identifies actions required to accomplish personal goals
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. self-directed course requires problem solving
   b. makes daily accommodations to stay on schedule
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. understands both written and verbal instructions
   b. understands step by step procedure to produce given tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. tasks require individualized practice to develop learning skills
   b. recognizes information to solve specific problems
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. understands welding terminology
   b. interprets different welding techniques
   c. chooses processes to accomplish specific tasks
   d. chooses procedures to accomplish specific tasks

C. ***Personal Qualities:*** *Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty.*

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. develops good work ethic
   b. self-directed study - student responsible for self-management
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. achievement in creating personal objectives
   b. ability to learn very challenging tasks independently
   c. successfully completes tasks with quality results
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. self-directed study requires adaptability working independently
4. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. accepts responsibility for own actions
   b. exhibits personal honesty at all times
   c. works with expensive tools and equipment - prompted to report all problems
   d. self-direction requires integrity and honesty to keep working and not misrepresent quality results

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MAST

COURSE SYLLABUS

INDIVIDUAL WELDING PROBLEMS II

MAST PROGRAM
COURSE SYLLABUS
INDIVIDUAL WELDING PROBLEMS II

Lecture hours/week: 0 **Lab hours/week: 5** **Credit hours: 3**

COURSE DESCRIPTION:

This is a self-directed study course. In other words the student is responsible for meeting all objectives which the student will create. In this course the student will prepare a written proposal identifying specific problems to be addressed and submit it to the instructor for approval by the end of the second week of the semester. This contract must be written. This contract will state class meeting time and required written work. Upon approval, the contract will be signed by the student and the instructor. The contract will then be attached to the syllabus. Students must make arrangements with instructor prior to signing up for class.

PREREQUISITES: **Basic Arc/Gas Welding I and II**

COURSE OBJECTIVES:

After the successful completion of this course the student will be able to the objective of the course and show evidence of completion of stated objectives.

1. Identify and define welding problems
2. Organize tasks and develop procedures for accomplishment
3. Develop independent work habits
4. Variable technical skills depending on individual problems
5. Acquire speed in work habits
6. Use safe work procedures

Major Concepts:

1. Self direction
2. Problem solving
3. Variable technical content
4. Develop speed
5. Develop safety

REQUIRED COURSE MATERIALS:

Textbook: None. Library assignments are substituted for required text.

Supplies: Specific supplies are dictated by objective.

1. Safety glasses - which will be worn at all times in the welding lab
2. Welders hood with a No. 10, 11 and 12 filter lens
3. Heavy gauntlet style welder's gloves
4. Chipping hammer

5. Wire brush
6. Pliers or vice grips
7. Appropriate clothing and shoes
8. Gas welding and cutting goggles (lens shade 5)

METHODS OF INSTRUCTION:

Laboratory: Laboratory will be "hands-on" activities.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments
2. apply theory to laboratory assignments
3. satisfactorily perform on written, oral, and practical examinations
4. satisfactorily perform on outside assignments including writing assignments
5. contribute to class discussions
6. maintain attendance per current policy
7. follow all shop rules and safety regulations as stated in the laboratory manual

LAB OUTLINE:

Lab Topic	Contact Hrs.
Self-Directed Study	—
Total Lab Hours	**80**

COURSE OBJECTIVES: TECHNICAL COMPETENCIES

After the successful completion of this course the student will be able to:

A. FOLLOW SAFE PRACTICES

1. Wear Personal Protective Equipment
   - a. List personal protective equipment for shielded metal arc welding
   - b. List personal protective equipment for gas tungsten arc welding
   - c. List personal protective equipment for gas metal arc welding
   - d. List personal protective equipment for flux cored arc welding
   - e. List personal protective equipment for submerged arc welding
   - f. List personal protective equipment for oxy-fuel cutting
   - g. List personal protective equipment for plasma arc cutting
   - h. List personal protective equipment for air carbon arc gouging
   - i. During shop work, wear applicable personal protective equipment at all times
2. Identify Safety Rules
   - a. List environmental safety precautions i.e. fume control, radiation reflection, electrical consideration, fire hazards and control, etc.
   - b. List equipment safety rules, i.e., ventilation, grounding, duty cycle
   - c. Utilize safety when handling and storing compressed gas cylinders

d. List general shop safety rules
e. Maintain safe conditions in workstation. Student demonstrate by setting up safe workstation.
f. Comply with confined space entry safety procedures
g. Conduct a safety inspection of the student work area
h. Conduct a safety inspection of the welding shop
i. Conduct a safety inspection of the gas storage area

3. Familiarize Oneself With Safety at Facility
   a. Attend safety tour of welding lab
   b. Receive a safety orientation lecture
   c. Avoid fumes through proper ventilation and good practices
   d. Operate exhaust system
   e. Practice electric safety with respect to welding
   f. Protection from radiation with an understanding of personal safety equipment and conduct
   g. Demonstrate a knowledge of fire prevention and protection for welding in dress and conduct
   h. List welding and cutting safety rules
   i. Demonstrate oxy-fuel gas cutting safety
   j. Demonstrate arc welding safety

B. DEMONSTRATE TECHNICAL COMMUNICATION

1. Use Standard American Welding Standard Society Welding Terms and Definitions
   a. Follow verbal instructions
   b. Follow written details
   c. Prepare time and job cards (reports & records)

C. MAINTAIN HOUSEKEEPING

1. Clean Work Area and Insure That No Safety Hazards Exist
   a. Sweep table top and floor in work area
   b. Clean equipment and tools
   c. Return tools to proper storage area
   d. Dispose of waste materials and scrap in their proper receptacle containers and storage areas
   e. Store all unused materials to their respective storage areas

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U. S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance.

The following activities will be performed by each student for successful completion of this course:

I. **COMPETENCIES**

A. ***Resources:*** *Identifies, organizes, plans, and allocates resources*
   1. self paced instruction with very little supervision requires time management
   2. projects require materials acquisition

B. ***Interpersonal:*** *Works with others*
   1. lab and class requires team work and cooperation to complete projects
   2. safety requires mutual cooperation, vigilance and communication

C. ***Information:*** *Acquires and uses information*
   1. reading assignments contain material students are responsible for which are to be obtained no where else
   2. lecture notes and research paper
   3. this is demonstrated by student's ability to complete projects

D. ***Systems:*** *Understands complex inter-relationships*
   1. program is geared toward training students to work and operate technology and system
   2. as the students learn welding skills they learn to monitor and correct their own performance

E. ***Technology:*** *Works with a variety of technologies*
   1. projects require selection of various technologies
   2. all projects require applied technology
   3. constant trouble shooting is required

II. **FOUNDATION SKILLS**

A. ***Basic Skills:*** *Reads, writes, performs arithmetic and mathematical operations, listens and speaks.*

   1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
      a. reads and comprehends homework assignments
      b. reads complicated written instruction

   2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
      a. completes written assignments and reports
      b. completes written essay questions

   3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
      a. converts fractions to decimals
      b. converts decimals to fractions
      c. adds, subtracts, multiplies and divides fractions
      d. computes angles

   4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
      a. interprets complicated verbal instructions

   5. ***Speaking:*** *Organizes ideas and communicates orally*
      a. responds to oral quiz questions
      b. capsulizes lecture information

B. ***Thinking Skills:*** *Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons.*

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   a. identifies personal goals
   b. identifies actions required to accomplish personal goals
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. self-directed course requires problem solving
   b. makes daily accommodations to stay on schedule
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. understands both written and verbal instructions
   b. understands step by step procedure to produce given tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. tasks require individualized practice to develop learning skills
   b. recognizes information to solve specific problems
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. understands welding terminology
   b. interprets different welding techniques
   c. chooses processes to accomplish specific tasks
   d. chooses procedures to accomplish specific tasks

C. ***Personal Qualities:*** *Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty.*

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. develops good work ethic
   b. self-directed study - student responsible for self-management
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. achievement in creating personal objectives
   b. ability to learn very challenging tasks independently
   c. successfully completes tasks with quality results
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. self-directed study requires adaptability working independently
4. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. accepts responsibility for own actions
   b. exhibits personal honesty at all times
   c. works with expensive tools and equipment - prompted to report all problems
   d. self-direction requires integrity and honesty to keep working and not misrepresent quality results

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MAST

COURSE SYLLABUS

BASIC PIPE WELDING I

MAST PROGRAM
COURSE SYLLABUS
BASIC PIPE WELDING I

Lecture hours/week: 1 **Lab hours/week: 4** **Credit hours: 3**

COURSE DESCRIPTION:

Shielded metal Arc Welding (SMAW) of pipe in the 2G and 5G positions. At the entry level of Basic Pipe Welding I, students are expected to pass AWS D1.1 qualification tests on ½" carbon steel plate in the 3G and 4G positions using SMAW.

PREREQUISITES: **Basic Arc/Gas Welding I and II; Advanced SMAW and Cutting I and II**

COURSE OBJECTIVES:

After the successful completion of this course the student will be able to:

1. The student using oxy-fuel gas cutting, will manually bevel pipe samples
2. The student will fit up and tack weld single V groove open root pipe joints to within given tolerances
3. The student will weld the pipe joint in the 1G, 2G and 5G positions to ASME IX

REQUIRED COURSE MATERIALS:

Textbook: **Pipe Welding Procedures**, by Hoobasar Rampaul

Supplies:

1. Safety Glasses - which will be worn at all times in the welding lab
2. Welder's hood with a No. 10, 11 and 12 filter lens
3. Heavy gauntlet style welder's gloves
4. Chipping Hammer
5. Wire Brush
6. Pliers or vice grips
7. Appropriate clothing and shoes
8. Gas welding and cutting goggles (lens shade 5)

Special Equipment:

1. Leather sleeves or jacket. Flame retarding clothing may be substituted at the student's discretion.
2. Bastard cut ½ round file
3. Welding hat
4. Safety glasses

5. Text
6. Flashlight

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be "hands-on" activities.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments
2. apply theory to laboratory assignments
3. satisfactorily perform on written, oral, and practical examinations
4. satisfactorily perform on outside assignments including writing assignments
5. contribute to class discussions
6. maintain attendance per current policy
7. follow all shop rules and safety regulations as stated in the laboratory manual

LECTURE OUTLINE:

Lecture Topics	Text Reference Page	Contact Hrs.
Safety review and special equipment		1
Preparation/tacking of pipe joint	Section 1, 16 and 4	2
Welding root pass 1/8" E6010	Section 2, 5	2
Welding hot pass and cover pass	Section 7	2
Test, each student will bend test for a grade		2
Horizontal position and stringer beads	Section 9	2
Begin final text, practical		2
Practical test and review and written test		2
Final test, written		2
	Total Lecture Hours	**18**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Preparation/tacking of pipe joint	
Welding root pass 1/8" E6010	
Welding hot pass and cover pass	
Horizontal position and stringer beads	
Total Lecture Hours	

COURSE OBJECTIVES: TECHNICAL COMPETENCIES

After the successful completion of this course the student will be able to:

A. FOLLOW SAFE PRACTICES

1. Wear Personal Protective Equipment
   a. List personal protective equipment for shielded metal arc welding
   b. List personal protective equipment for gas tungsten arc welding
   c. List personal protective equipment for gas metal arc welding
   d. List personal protective equipment for flux cored arc welding
   e. List personal protective equipment for submerged arc welding
   f. List personal protective equipment for oxy-fuel cutting
   g. List personal protective equipment for plasma arc cutting
   h. List personal protective equipment for air carbon arc gouging
   i. During shop work, wear applicable personal protective equipment at all times
2. Identify Safety Rules
   a. List environmental safety precautions i.e. fume control, radiation reflection, electrical consideration, fire hazards and control, etc.
   b. List equipment safety rules, i.e., ventilation, grounding, duty cycle
   c. Utilize safety when handling and storing compressed gas cylinders
   d. List general shop safety rules
   e. Maintain safe conditions in workstation. Student demonstrate by setting up safe workstation.
   f. Comply with confined space entry safety procedures
   g. Conduct a safety inspection of the student work area
   h. Conduct a safety inspection of the welding shop
   i. Conduct a safety inspection of the gas storage area
3. Familiarize Oneself With Safety at Facility
   a. Attend safety tour of welding lab
   b. Receive a safety orientation lecture
   c. Avoid fumes through proper ventilation and good practices
   d. Operate exhaust system
   e. Practice electric safety with respect to welding
   f. Protection from radiation with an understanding of personal safety equipment and conduct
   g. Demonstrate a knowledge of fire prevention and protection for welding in dress and conduct
   h. List welding and cutting safety rules
   i. Demonstrate oxy-fuel gas cutting safety
   j. Demonstrate arc welding safety

B. DEMONSTRATE TECHNICAL COMMUNICATION

1. Use Standard American Welding Standard Society Welding Terms and Definitions
   a. Follow verbal instructions
   b. Follow written details
   c. Prepare time and job cards (reports & records)

C. ADVANCED SHIELDED METAL ARC WELDING (SMAW) AND CUTTING

1. Weld Various Diameters of Pipe to Plate
   a. Inspect area for safety
   b. Place plate flat on welding table
   c. Place 3" pipe vertically on top of plate and tacked in place
   d. Leave weld coupon in the 2F fixed position
   e. Apply a 3/8" fillet weld using 1/8" E7018 and a stringer bead technique
   f. Visually inspect weld to AWS D1.1
   g. Fill pipe with water for 24 hours
   h. Check for leak
2. Produce SMAW Pipe - 5G Position
   a. Measure the pipe
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Tack the single V groove pipe joint with a 3/32" root opening
   g. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   h. Chip slag and wire brush weld
   i. Grind any lack of fusion and/or high spots
   j. Weld the balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
   k. Visually inspect weld on the root and face sides to ASME Section 9
   l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria
3. Produce SMAW - 2G Position Groove Welds
   a. Measure the pipe
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Tack the single V groove pipe joint with a 3/32" root opening
   g. Weld pipe joint
   h. Place the joint in the 2G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
   j. Weld balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
   k. Visually inspect weld on the root and face sides to ASME Section 9
   l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten

are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

4. Roll Weld Pipe - SMAW
   a. Measure the pipe
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Tack the single V groove pipe joint with a 3/32" root opening
   g. Roll weld pipe
   h. Place pipe coupon on workbench in the 1G roll welding position.
   i. Weld the root bead using 1/8" E6010 and the keyhole technique. The weld is performed in the 2:00 to 12:30 position
   j. Chip slag and wire brush. Grind any lack of fusion and/or high spots
   k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
   l. Visually inspect weld on the root and face sides to ASME Section 9
   m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

5. Produce SMAW Pipe - 5G Position
   a. Measure the pipe and
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Weld pipe
   g. Tack the single V groove pipe joint with a 3/32" root opening
   h. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique
   i. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   j. Chip slag and wire brush. Grind any lack of fusion and/or high spots
   k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
   l. Visually inspect weld on the root and face sides to ASME Section 9
   m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

D. PIPE WELDING - SMAW

1. Produce End Preparations
   a. Produce end preparations with oxy-fuel cutting
   b. Produce end preparations with plasma cutting
   c. Produce end preparations with mechanical cutting
   d. Produce end preparations with grinding

2. Fit and Tack Weld Pipe
   a. Cut and single bevel pipe to 37 1/2°
   b. Ground bevel face and touch up to within tolerances
   c. Check that pipe ends are square within given tolerances
   d. Prepare root face within given tolerances
   e. Align pipe to within given tolerances
   f. Set root opening to within given tolerances
   g. Tack pipe according to welding procedure specification - maintaining root opening
3. Roll Weld Open Root Pass on Pipe - 1G Position
   a. Fit up and tack pipe joint using 1/8" E6010 electrode, weld the root pass on pipe in the 1 o'clock to (2:00 o'clock position) according to procedure using the roll welding technique
   b. Weld remainder of pipe in the 1G roll welding position with E6010
   c. Weld the remaining portion of the groove using the weave technique using 5/32" E6010 electrode roll
4. Weld Open Root Pipe Joint - 2G Position
   a. Weld using 1/8" E6010
   b. Cut and grind pipe ends will be to single bevel edge preparations of 37 1/2°
   c. Fit together the two pipe ends to a single V edge preparation with given tolerances
   d. Weld root pass to ASME Section 9 requirements
   e. Fill balance of the groove with E6010 using the stringer technique to ASME Section 9 requirements
5. Weld Open Root Pipe - 5G Position
   a. Fit and tack weld pipe to within tolerances
   b. Place pipe in the 5G position
   c. Weld the rootpass using 1/8" E6010 to ASME Section 9 requirements
   d. Grind the finished root pass to remove high spots and any slag at weld toes
   e. Weld the remainder of the groove using 3/32" and/or 1/8" E7018 using the stringer bead technique to ASME Section 9 requirements
6. Pass Guided Bond Tests Per ASME Section 9
   a. Remove bend samples from pipe at the 10, 2, 8 & 4 o'clock positions
   b. If the material is 3/8" or thinner 10 o'clock and 8 o'clock receive root bends and 2 o'clock and 4 o'clock receive face bends. If the pipe wall thickness is over 3/8" side bends shall be performed on all samples.
   c. Weld remainder of pipe in 1G position using E7018
   d. Perform low hydrogen starts and stops
   e. Weld using stringer bead technique
   f. Weld using weave technique
   g Chip slag wire brush and grind as necessary to assure clean weld deposits
7. Weld Open Root Pipe - 2G Position
   a. Use 1/8" E6010
   b. Cut and ground pipe ends to single bevel edge preparations of 37 1/2° c.Fit together two pipe ends to a single V edge preparation within given tolerances
   c. Weld root pass to ASME Section 9 requirements

d. Clean weld pass by chipping slag, wire brushing and grinding where necessary to assure a clean, well fused weld deposit
e. Weld remainder of the groove using E7018 with the stringer bead technique

E. MAINTAIN HOUSEKEEPING

1. Clean Work Area and Insure That No Safety Hazards Exist
   a. Sweep table top and floor in work area
   b. Clean equipment and tools
   c. Return tools to proper storage area
   d. Dispose of waste materials and scrap in their proper receptacle containers and storage areas
   e. Store all unused materials to their respective storage areas

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U. S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance.

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

A. Resources: Identifies, organizes, plans, and allocates resources
   1. self paced instruction with very little supervision requires time management
   2. projects require materials acquisition

B. Interpersonal: Works with others
   1. lab and class requires team work and cooperation to complete projects
   2. safety requires mutual cooperation, vigilance and communication

C. Information: Acquires and uses information
   1. reading assignments contain material students are responsible for which are to be obtained no where else
   2. lecture notes and research paper
   3. this is demonstrated by student's ability to complete projects

D. Systems: Understands complex inter-relationships
   1. program is geared toward training students to work and operate technology and system
   2. as the students learn welding skills they learn to monitor and correct their own performance

E. Technology: Works with a variety of technologies
   1. projects require selection of various technologies
   2. all projects require applied technology

3. constant trouble shooting is required

II. FOUNDATION SKILLS

A. ***Basic Skills:*** *Reads, writes, performs arithmetic and mathematical operations, listens and speaks.*

1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*

a. reads and comprehends homework assignments
b. reads complicated written instruction

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*

a. completes written assignments and reports
b. completes written essay questions

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*

a. converts fractions to decimals
b. converts decimals to fractions
c. adds, subtracts, multiplies and divides fractions
d. computes angles

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*

a. attends lectures
b. interprets complicated verbal instructions

5. ***Speaking:*** *Organizes ideas and communicates orally*

a. responds to oral quiz questions
b. capsulizes lecture information

B. ***Thinking Skills:*** *Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons.*

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*

a. identifies personal goals
b. identifies actions required to accomplish personal goals

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*

a. answer assigned questions
b. makes daily accommodations to stay on schedule

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*

a. understands both written and verbal instructions
b. understands step by step procedure to produce given tasks

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*

a. tasks require individualized practice to develop learning skills
b. recognizes information to solve specific problems

5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. understands welding terminology
   b. interprets different welding techniques
   c. chooses processes to accomplish specific tasks
   d. chooses procedures to accomplish specific tasks

C. ***Personal Qualities:*** *Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty.*

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. develops good work ethic
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. achievement in class objectives
   b. ability to learn very challenging tasks
   c. successfully completes tasks with quality results
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. working together with other students in safety
   b. working together with other students in learning
   c. assigned to group projects and assignments
4. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. accepts responsibility for own actions
   b. exhibits personal honesty at all times
   c. works with expensive tools and equipment - prompted to report all problems

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MAST

COURSE SYLLABUS

BASIC PIPE WELDING II

MAST PROGRAM
COURSE SYLLABUS
BASIC PIPE WELDING II

Lecture hours/week: 1 **Lab hours/week: 4** **Credit hours: 3**

COURSE DESCRIPTION:

Shielded metal arc welding (SMAW) of pipe in the 6G positions. At the entry level of Basic Pipe Welding II, students are expected to pass AWS D1.1 qualification tests on 6" schedule 40 carbon steel pipe in the 2G and 5G positions using SMAW.

PREREQUISITES: **Basic Arc/Gas Welding I and II; Advanced SMAW and Cutting I and II; Basic Pipe Welding I**

COURSE OBJECTIVES:

After the successful completion of this course the student will be able to:

1. Advanced welding skills
2. Pass ASME guided bend tests:
   a. root bends
   b. face bends
   c. side bends

Major Concepts:

1. Pipe welding
2. Pipe cutting and weld joint preparation
3. Safety
4. Understand the ASME pipe test
5. Attendance
6. Punctuality

REQUIRED COURSE MATERIALS:

Textbook: **Pipe Welding Procedures**, by Hoobasar Rampaul

Supplies:

1. Safety glasses - which will be worn at all times in the welding lab
2. Welder's hood with a No. 10, 11 and 12 filter lens
3. Heavy gauntlet style welder's gloves
4. Chipping hammer
5. Pliers or vice grips
6. Appropriate clothing and shoes
7. Gas welding and cutting goggles (lens shade 5)

Special Equipment:

1. Leather sleeves or jacket. Flame retardant clothing may be substituted at the student's discretion.
2. Bastard cut ½ round file
3. Welding hat
4. Safety glasses
5. Text
6. Flashlight

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be "hands-on" activities.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments
2. apply theory to laboratory assignments
3. satisfactorily perform on written, oral, and practical examinations
4. satisfactorily perform on outside assignments including writing assignments
5. contribute to class discussions
6. maintain attendance per current policy
7. follow all shop rules and safety regulations as stated in the laboratory manual

LECTURE OUTLINE:

Lecture Topics	Text Reference Page	Contact Hrs.
Preparation/tacking of pipe joint 6G position	Sections Review 16 and 4	2
Welding root pass 1/8" E6010 6G position	Section 15 Review 5	3
Welding intermediate and cover pass with low hydrogen procedures. Write a procedure.	Section 13 Review 6	3
Test, each student will bend test for a grade		2
Begin review	Section 11	2
Begin final test, practical	Section 12	2
Practical test and review for written test	Section 14	2
Final test, written		2
	Total Lecture Hours	**18**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Preparation/tacking of pipe joint in 6G position	
Welding root pass 1/8" E6010 in 6G position	
Welding intermediate and cover pass with low low hydrogen procedures	
Total Lab Hours	—

COURSE OBJECTIVES: TECHNICAL COMPETENCIES

After the successful completion of this course the student will be able to:

A. FOLLOW SAFE PRACTICES

1. Wear Personal Protective Equipment
   a. List personal protective equipment for shielded metal arc welding
   b. List personal protective equipment for gas tungsten arc welding
   c. List personal protective equipment for gas metal arc welding
   d. List personal protective equipment for flux cored arc welding
   e. List personal protective equipment for submerged arc welding
   f. List personal protective equipment for oxy-fuel cutting
   g. List personal protective equipment for plasma arc cutting
   h. List personal protective equipment for air carbon arc gouging
   i. During shop work, wear applicable personal protective equipment at all times
2. Identify Safety Rules
   a. List environmental safety precautions i.e. fume control, radiation reflection, electrical consideration, fire hazards and control, etc.
   b. List equipment safety rules, i.e., ventilation, grounding, duty cycle
   c. Utilize safety when handling and storing compressed gas cylinders
   d. List general shop safety rules
   e. Maintain safe conditions in workstation. Student demonstrate by setting up safe workstation.
   f. Comply with confined space entry safety procedures
   g. Conduct a safety inspection of the student work area
   h. Conduct a safety inspection of the welding shop
   i. Conduct a safety inspection of the gas storage area
3. Familiarize Oneself With Safety at Facility
   a. Attend safety tour of welding lab
   b. Receive a safety orientation lecture
   c. Avoid fumes through proper ventilation and good practices
   d. Operate exhaust system
   e. Practice electric safety with respect to welding
   f. Protection from radiation with an understanding of personal safety equipment and conduct
   g. Demonstrate a knowledge of fire prevention and protection for welding in dress and conduct
   h. List welding and cutting safety rules

i. Demonstrate oxy-fuel gas cutting safety
j. Demonstrate arc welding safety

B. DEMONSTRATE TECHNICAL COMMUNICATION

1. Use Standard American Welding Standard Society Welding Terms and Definitions
   a. Follow verbal instructions
   b. Follow written details
   c. Prepare time and job cards (reports & records)

C. ADVANCED SHIELDED METAL ARC WELDING (SMAW) AND CUTTING

1. Produce SMAW Pipe - 6G Position
   a. Measure the pipe
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Tack the single V groove pipe joint with a 3/32" root opening
   g. Place the joint in the 6G fixed position, using an 1/8" E6010 and a keyhole technique
   h. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
   j. Weld balance of groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
   k. Visually inspect weld on the root and face sides to ASME Section 9
   l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria
2. Create SMAW Pipe to ASME Section 9
   a. Bevel two pieces of pipe to 30° bevel angle using oxy-fuel gas cutting equipment
   b. Clean bevel face and a 3/32" root face is applied using a hand held grinder
   c. Set welding condition to weld open roots
   d. Tack pipe nipples together to form a V groove with a 1/8" root opening
   e. Place pipe in the 5G fixed position. The root pass is welded and cleaned by wire brushing
   f. Weld balance of the V groove with this procedure
   g. Visual inspection is made and evaluated by ASME Section 9
   h. Make four bend samples and evaluate by ASME Section 9

D. PIPE WELDING - SMAW

1. Produce End Preparations
   a. Produce end preparations with oxy-fuel cutting
   b. Produce end preparations with plasma cutting
   c. Produce end preparations with mechanical cutting
   d. Produce end preparations with grinding
2. Fit and Tack Weld Pipe
   a. Cut and single bevel pipe to 37 1/2°
   b. Ground bevel face and touch up to within tolerances

c. Check that pipe ends are square within given tolerances
d. Prepare root face within given tolerances
e. Align pipe to within given tolerances
f. Set root opening to within given tolerances
g. Tack pipe according to welding procedure specification - maintaining root opening

3. Roll Weld Open Root Pass on Pipe - 1G Position
   a. Fit up and tack pipe joint using 1/8" E6010 electrode, weld the root pass on pipe in the 1 o'clock to (2:00 o'clock position) according to procedure using the roll welding technique
   b. Weld remainder of pipe in the 1G roll welding position with E6010
   c. Weld the remaining portion of the groove using the weave technique using 5/32" E6010 electrode roll
4. Weld Open Root Pipe Joint - 2G Position
   a. Weld using 1/8" E6010
   b. Cut and grind pipe ends will be to single bevel edge preparations of 37 1/2°
   c. Fit together the two pipe ends to a single V edge preparation with given tolerances
   d. Weld root pass to ASME Section 9 requirements
   e. Fill balance of the groove with E6010 using the stringer technique to ASME Section 9 requirements
5. Weld Pipe Open Root Passes All Positions Using GMAW
   a. Set up GMAW equipment
   b. Adjust wire feeder drive system
   c. Adjust shielding gas system and flow rate
   d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
   e. Set welding condition for short circuit transfer - Wire Feed Speed
   f. Set welding condition for short circuit transfer - Voltage
   g. Set welding condition for short circuit transfer - Tip to work Distance
   h. Weld root using a string bead technique
6. Weld Pipe With Backing Using FCAW-G
   a. Bevel pipe ends
   b. Touch up bevel face with grinder
   c. Fit and tack backing ring to one pipe end
   d. Fit other pipe over backing ring
   e. Adjust gap and tack in place
   f. Adjust shielding gas flow
   g. Adjust wire feed system
   h. Adjust power source to procedure specification
   i. Set wire feed speed to procedure specification
   j. Adjust voltage to procedure specification
   k. Adjust inductance to procedure specification
   l. Adjust GMAW gun for tip to work distance and shielding gas
   m. Weld according to procedure specification

E. MAINTAIN HOUSEKEEPING

1. Clean Work Area and Insure That No Safety Hazards Exist
   a. Sweep table top and floor in work area

b. Clean equipment and tools
c. Return tools to proper storage area
d. Dispose of waste materials and scrap in their proper receptacle containers and storage areas
e. Store all unused materials to their respective storage areas

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b. reads complicated written instruction

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   b. completes written essay questions
3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. converts fractions to decimals
   b. converts decimals to fractions
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   b. identifies actions required to accomplish personal goals
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. answer assigned questions
   b. makes daily accommodations to stay on schedule
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. understands both written and verbal instructions
   b. understands step by step procedure to produce given tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. tasks require individualized practice to develop learning skills
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5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. understands welding terminology
   b. interprets different welding techniques
   c. chooses processes to accomplish specific tasks
   d. chooses procedures to accomplish specific tasks

C. ***Personal Qualities:*** *Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty.*

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. develops good work ethic
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. achievement in class objectives
   b. ability to learn very challenging tasks
   c. successfully completes tasks with quality results
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. working together with other students in safety
   b. working together with other students in learning
   c. assigned to group projects and assignments
4. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. accepts responsibility for own actions
   b. exhibits personal honesty at all times
   c. works with expensive tools and equipment - prompted to report all problems

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MAST

COURSE SYLLABUS

VISUAL INSPECTION OF WELDS

MAST PROGRAM
COURSE SYLLABUS
VISUAL INSPECTION OF WELDS

Lecture hours/week: 3 **Lab hours/week: 0** **Credit hours: 3**

COURSE DESCRIPTION:

Using visual inspection, the student will determine if a weld meets given code requirements in size, configuration, profile, process, acceptable discontinuities, print requirements, procedure requirements, qualification requirements, etc.

PREREQUISITES: **NONE**

COURSE OBJECTIVES:

After the successful completion of this course the student will be able to:

1. Given a lecture/discussion on the Metric measuring system as it pertains to welded structures, the student will be able to convert standard measurements to metric measurements as they pertain to welding of the various joints to a 3B/B training standard
2. Given a lecture/discussion on joint design, the student will identify the parts to a welded joint to a "C" Training Standard
3. Given a lecture/discussion on joint design, the student will use various tools to give a description of the joint and detail to a "C" Training Standard of 3
4. Given a lecture/discussion on weld bead types, the student will identify selected weld samples to a "C" Training Standard
5. Given a lecture/discussion and demonstration on welding processes, the student will identify welding processes to a Student Training Standard (3B/B)
6. Given a lecture/discussion on visual weld defects, the student will identify weld discontinuities to a 3B/B Training Standard
7. Given a lecture/discussion on selected codes, the student will classify as acceptable/unacceptable selected weld samples to a 3B/C Training Standard
8. Given a lecture/discussion on the procedure for weld inspection the student will explain and document a weld inspection to a 3B/B Training Standard
9. Given a lecture/discussion on weld size and weld gauges the student will gage various welds to a Student Training Standard (3B/B)
10. The student will produce a 10 page written report on visual welding inspection as it relates to a given welding process

REQUIRED COURSE MATERIALS:

Textbook: American Welding Society, Welding Inspection, 2nd Edition, Miami, FL, 1980

Supplies: None required

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments
2. apply theory to laboratory assignments
3. satisfactorily perform on written, oral, and practical examinations
4. satisfactorily perform on outside assignments including writing assignments
5. contribute to class discussions
6. maintain attendance per current policy
7. follow all shop rules and safety regulations as stated in the laboratory manual

LECTURE OUTLINE:

Lecture Topics	Text Reference Page	Contact Hrs.
Convert standard measurements to metric measurements		4
Identify parts to a welded joint		4
Use various tools to give a description of the joint		4
Identify selected weld samples		4
Identify welding processes		12
Identify weld discontinuities		8
Classify as acceptable/unacceptable selected weld samples		6
Explain and document a weld inspection		4
Gage various welds		2
Produce a ten page written report		—
	Total Lecture Hours	**48**

COURSE OBJECTIVES: TECHNICAL COMPETENCIES

After the successful completion of this course the student will be able to:

A. QUALITY INSPECTIONS

1. Perform Visual Checks
   - a. Identify common welding defects
   - b. List terms for common welding defects
   - c. Rate common welding defects in order of severity
   - d. Name size of limitations for defects given under various codes

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U. S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance.

The following activities will be performed by each student for successful completion of this course:

I. **COMPETENCIES**

- *A.* ***Resources:*** *Identifies, organizes, plans, and allocates resources*
  1. self paced instruction with very little supervision requires time management
  2. projects require materials acquisition
- *B.* ***Interpersonal:*** *Works with others*
  1. lab and class requires team work and cooperation to complete projects
  2. safety requires mutual cooperation, vigilance and communication
- *C.* ***Information:*** *Acquires and uses information*
  1. reading assignments contain material students are responsible for which are to be obtained no where else
  2. lecture notes and research paper
  3. this is demonstrated by student's ability to complete projects
- *D.* ***Systems:*** *Understands complex inter-relationships*
  1. program is geared toward training students to work and operate technology and system
  2. as the students learn welding skills they learn to monitor and correct their own performance
- *E.* ***Technology:*** *Works with a variety of technologies*
  1. projects require selection of various technologies
  2. all projects require applied technology
  3. constant trouble shooting is required

II. **FOUNDATION SKILLS**

- *A.* ***Basic Skills:*** *Reads, writes, performs arithmetic and mathematical operations, listens and speaks.*
  - *1.* ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
    - a. reads and comprehends homework assignments
    - b. reads complicated written instruction
  - *2.* ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
    - a. completes written assignments and reports
    - b. completes written essay questions

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. converts fractions to decimals
   b. converts decimals to fractions
   c. adds, subtracts, multiplies and divides fractions
   d. computes angles
4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. attends lectures
   b. interprets complicated verbal instructions
5. ***Speaking:*** *Organizes ideas and communicates orally*
   a. responds to oral quiz questions
   b. capsulizes lecture information

B. ***Thinking Skills:*** *Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons.*
1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   a. identifies personal goals
   b. identifies actions required to accomplish personal goals
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. answer assigned questions
   b. makes daily accommodations to stay on schedule
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. understands both written and verbal instructions
   b. understands step by step procedure to produce given tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. tasks require individualized practice to develop learning skills
   b. recognizes information to solve specific problems
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. understands welding terminology
   b. interprets different welding techniques
   c. chooses processes to accomplish specific tasks
   d. chooses procedures to accomplish specific tasks

C. ***Personal Qualities:*** *Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty.*
1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. develops good work ethic
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. achievement in class objectives
   b. ability to learn very challenging tasks

c. successfully completes tasks with quality results

3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. working together with other students in safety
   b. working together with other students in learning
   c. assigned to group projects and assignments

4. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. accepts responsibility for own actions
   b. exhibits personal honesty at all times
   c. works with expensive tools and equipment - prompted to report all problems

APPENDIX A - INDUSTRY COMPETENCY PROFILES

The following pages contain the individual Competency Profiles for each of the companies surveyed by the MAST development center for the occupational specialty area of . These Competency Profiles/skill standards were used to develop the curriculum for the pilot program.

The participation of the companies as partners in the MAST effort is greatly appreciated. Each company has approved the use of its logo in MAST materials. None of the participating companies shall be held responsible or liable for any of the findings of the project.

SKILLS AND KNOWLEDGE

Communication Skills
Use Measurement Tools
Use Inspection Devices
Mathematical Skills
Reading/Writing Skills
Knowledge of Safety Regulations
Practice Safety in the Workplace
Organizational Skills
Knowledge of Company Policies/Procedures
Mechanical Aptitude
Ability to Comprehend Written/Verbal Instructions
Knowledge of Cutting Fluids/Lubricants
Basic Knowledge of Fasteners
Ability to Work as Part of a Team
Converse in the Technical Language of the Trade
Knowledge of Occupational Opportunities
Knowledge of Employee/Employer Responsibilities
Knowledge of Company Quality Assurance Activities
Practice Quality-Consciousness in Performance of the Job

TEXAS STATE TECHNICAL COLLEGE WACO
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Director

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Assistant Director

JOE PENICK
Project Coordinator

TERRY SAWMA
Research Coordinator

WALLACE PELTON
Site Coordinator

ROSE MARY TIMMONS
Senior Secretary/Statistician

Furnished By:

MICHAEL CANADA
Assistant Director of Manufacturing

RICHARD M. WONG
Sr. Manufacturing Engineer

JUAN SILVA
Welder

Texas State Technical College Waco

TRAITS AND ATTITUDES

Strong Work Ethic
Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Conscientious
Motivation
Responsible
Physical Ability
Professional
Trustworthy
Customer Relations
Personal Ethics

TOOLS AND EQUIPMENT

FUTURE TRENDS AND CONCERNS

COMPETENCY PROFILE

Welder

Prepared By
M.A.S.T.
Machine Tool Advanced Skills
Technology Program
and
Consortia Partners
(V.199J40008)

Texas State Technical College Waco

BOWEN®

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WELDER .... interpret drawings; cut and prepare materials; layout and fitup work; select and setup welding devices; and perform welding operations necessary to produce a workpiece fabricated to standard.

Duties	Tasks												
A Practice Safety	A-1 Follow safety manuals and all safety regulations/ requirements	A-2 Set up and use welding equipment	A-3 Wear personal safety equipment	A-4 Maintain a clean and safe work environment									
B Determine Weld-Related Requirements	B-1 Interpret drawings and blueprints	B-2 Perform measurement and inspection	B-3 Analyze Bill of Materials (BOM)	B-4 Set-up welding process(es)	B-5 Identify electrical fundamentals								
C Layout and Fitup	C-1 Use jigs and fixtures in layout and fitup	C-2 Prepare joints for welding with oxy-fuel, plasma arc and/or air carbon arc	C-3 Identify the various structural shapes and the preparation of same for layout and fitup	C-4 Identify methods for straightening and removing damaged structural and machinery parts	C-5 Prepare joints for welding with mechanical means	C-6 Perform post-fabrication activities	C-7 Operate sheetmetal brake	C-8 Cold roll steel and aluminum plate					
D Perform Shielded Metal Arc Welding (SMAW)	D-1 Identify SMAW welding variables	D-2 Identify the various types of SMAW power sources	D-3 Properly select the correct electrodes for various AISI steels and welding applications	D-4 Perform SMAW on a steel plate to a satisfactory quality level	D-5 Perform in-process rework	D-6 Perform in-process weld inspection	D-7 Weld pipe of various materials in various positions						
E Operate GMAW and FCAW Equipment	E-1 Identify GMAW and FCAW equipment	E-2 Match electrode material to various base metals	E-3 Identify welding variables and their effects upon weld quality	E-4 GMAW fillet and groove welds on T and butt joints with short circuit transfer method	E-5 GMAW fillet and groove welds with spray transfer method	E-6 FCAW mild steel plate with shielded and non-shielded core	E-7 Perform in-process rework	E-8 Perform in-process weld inspection	E-9 FCAW pipe of various materials in various positions				
F Operate Gas Tungsten Arc Welding (GTAW) Equipment	F-1 Identify GTAW equipment	F-2 Match electrodes to various base metals	F-3 Identify GTAW welding variables and their effects on weld quality	F-4 GTAW fillet and groove welds on T and butt joints on various metals in various positions	F-5 Perform in-process rework	F-6 Perform in-process weld inspection							
G Hardsurface Metal Parts and Weld Cast Iron	G-1 Hard-surface carbon and alloy steels	G-2 Identify cast iron and cast steel and prepare for welding	G-3 SMAW cast iron	G-4 Perform in-process rework	G-5 Perform in-process weld inspection								
H Perform Oxyacetylene Welding and Cutting	H-1 Identify the function of equipment and consumables	H-2 Weld mild steel sheet metal	H-3 Brazeweld steel and cast iron	H-4 Use appropriate brazing techniques to braze various types of tubing	H-5 Cut mild steel plate	H-6 Lead fill joints							
I Perform Air Carbon Arc (AAC) Cutting	I-1 Identify and set up the equipment associated with AAC cutting	I-2 Operate air carbon arc cutting equipment											
J Perform Plasma Arc Cutting (PAC)	J-1 Identify and set up PAC equipment	J-2 Operate Plasma Arc Cutting equipment											

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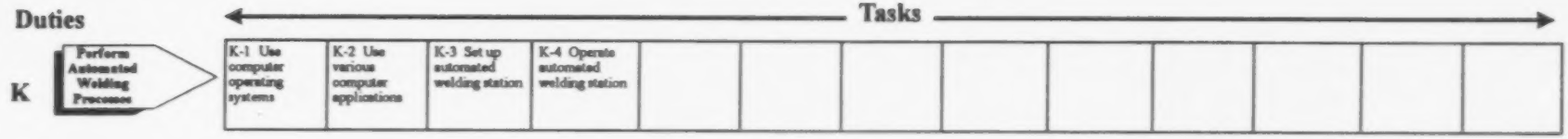
Duties
Tasks
K
Perform Automated Welding Processes
K-1 Use computer operating systems
K-2 Use various computer applications
K-3 Set up automated welding station
K-4 Operate automated welding station

SKILLS AND KNOWLEDGE

Communication Skills
Use Measurement Tools
Use Inspection Devices
Mathematical Skills
Reading/Writing Skills
Knowledge of Safety Regulations
Practice Safety in the Workplace
Organizational Skills
Knowledge of Company Policies/Procedures
Mechanical Aptitude
Ability to Comprehend Written/Verbal Instructions
Basic Knowledge of Fasteners
Ability to Work as Part of a Team
Converse in the Technical Language of the Trade
Knowledge of Occupational Opportunities
Knowledge of Employee/Employer Responsibilities
Knowledge of Company Quality Assurance Activities
Practice Quality-Consciousness in Performance of the Job

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Senior Secretary/Statistician

Furnished By:
LARRY WRIGHT
THOMAS MEJORADO

Texas State Technical College Waco

TRAITS AND ATTITUDES

Strong Work Ethic
Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Conscientious
Motivation
Responsible
Physical Ability
Professional
Trustworthy
Customer Relations
Personal Ethics

TOOLS AND EQUIPMENT

Mechanic's Tools (e.g., toolbox, wrenches, sockets, hammers, etc.
Measuring Tools
Power Tools
Drill Presses
Power Saws
Power Drills
Hydraulic/Arbor Press
SMAW Equipment
GMAW Equipment
FCAW Equipment
Plasma Arc Cutter
Oxyacetylene Equipment
Air Carbon Arc Cutter
Exothermic Rod Cutter (Mini Torch)
Track Torch
Alignment/Calibration Tools
Computer
Forklift
Personal Safety Equipment
Tool Storage Equipment
Workbenches
Vises
Pedestal Grinders
Air Compressor
Air Powered Tools
Hydraulic Jack
Chain Hoist

FUTURE TRENDS AND CONCERNS

COMPETENCY PROFILE

Welder

Prepared By
M.A.S.T.
Machine Tool Advanced Skills
Technology Program
and
Consortia Partners
(V.199J40008)

Texas State Technical College Waco

DARR EQUIPMENT CO.
CAT

WELDER .... interpret drawings; cut and prepare materials; layout and fitup work; select and setup welding devices; and perform welding operations necessary to produce a workpiece fabricated to standard.

Duties	Tasks												
A Practice Safety	A-1 Follow safety manuals and all safety regulations/ requirements	A-2 Set up and use welding equipment	A-3 Wear personal safety equipment	A-4 Maintain a clean and safe work environment									
B Determine Weld-Related Requirements	B-1 Interpret drawings and blueprints	B-2 Perform measurement and inspection	B-3 Analyze Bill of Materials (BOM)	B-4 Set-up welding process(es)	B-5 Identify electrical fundamentals								
C Layout and Fitup	C-1 Use jigs and fixtures in layout and fitup	C-2 Prepare joints for welding with oxy-fuel, plasma arc and/or air carbon arc	C-3 Identify the various structural shapes and the preparation of same for layout and fitup	C-4 Identify methods for straightening and removing damaged structural and machinery parts	C-5 Prepare joints for welding with mechanical means	C-6 Perform post-fabrication activities							
D Perform Shielded Metal Arc Welding (SMAW)	D-1 Identify SMAW welding variables	D-2 Identify the various types of SMAW power sources	D-3 Properly select the correct electrodes for various AISI steels and welding applications	D-4 Perform SMAW on a steel plate to a satisfactory quality level	D-5 Perform in-process rework	D-6 Perform in-process weld inspection	D-7 Weld pipe of various materials in various positions						
E Operate GMAW and FCAW Equipment	E-1 Identify GMAW and FCAW equipment	E-2 Match electrode material to various base metals	E-3 Identify welding variables and their effects upon weld quality	E-4 GMAW fillet and groove welds on T and butt joints with short circuit transfer method	E-5 GMAW fillet and groove welds with spray transfer method	E-6 FCAW mild steel plate with shielded and non-shielded core	E-7 Perform in-process rework	E-8 Perform in-process weld inspection					
F Operate Gas Tungsten Arc Welding (GTAW) Equipment	F-1 Identify GTAW equipment	F-2 Match electrodes to various base metals	F-3 Identify GTAW welding variables and their effects on weld quality	F-4 GTAW fillet and groove welds on T and butt joints on various metals in various positions	F-5 Perform in-process rework	F-6 Perform in-process weld inspection							
G Hardsurface Metal Parts and Weld Cast Iron	G-1 Hardsurface carbon and alloy steels	G-2 Identify cast iron and cast steel and prepare for welding	G-3 SMAW cast iron	G-4 Perform in-process rework	G-5 Perform in-process weld inspection								
H Perform Oxyacetylene Welding and Cutting	H-1 Identify the function of equipment and consumables	H-2 Weld mild steel sheet metal	H-3 Brazeweld steel and cast iron	H-4 Use appropriate brazing techniques to braze various types of tubing	H-5 Cut mild steel plate	H-6 Operate torch track cutter							
I Perform Air Carbon Arc (AAC) and Exothermic Rod Cutting	I-1 Identify and set up the equipment associated with AAC cutting	I-2 Operate air carbon arc cutting equipment	I-3 Operate exothermic rod cutter (mini torch)										
J Perform Plasma Arc Cutting (PAC)	J-1 Identify and set up PAC equipment	J-2 Operate Plasma Arc Cutting equipment											

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SKILLS AND KNOWLEDGE

Communication Skills
Use Measurement Tools
Use Inspection Devices
Mathematical Skills
Reading/Writing Skills
Knowledge of Safety Regulations
Practice Safety in the Workplace
Organizational Skills
Mechanical Aptitude
Ability to Comprehend Written/Verbal Instructions
Basic Knowledge of Fasteners
Ability to Work as Part of a Team
Converse in the Technical Language of the Trade
Knowledge of Occupational Opportunities
Knowledge of Employee/Employer Responsibilities
Knowledge of Company Quality Improvement Activities
Practice Quality-Consciousness in Performance of the Job

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RON STEPHENS, Human Resources Manager
ELAINE SWIGART, Human Resources Supervisor
DONNA TACKETT, Health & Safety Supervisor
BILL RHODES, Production Manager/Body Plant

TRAITS AND ATTITUDES

Strong Work Ethic
Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Awareness
Motivation
Responsible
Physical Ability
Professional
Trustworthy
Customer Relations
Personal Ethics

TOOLS AND EQUIPMENT

Mechanic's Tools (e.g., toolbox, wrenches, sockets, hammers, etc.)
Measuring Tools
Power Tools
Drill Presses
Power Saws
Power Drills
Hydraulic/Arbor Press
SMAW Equipment
GMAW Equipment
Plasma Arc Cutter
Oxyacetylene Equipment
Air Carbon Arc Cutter
Exothermic Rod Cutter (Mini Torch)
Track Torch
Alignment/Calibration Tools
Computer
Forklift
Personal Safety Equipment
Workbenches
Vises
Pedestal Grinders
Air Compressor
Air Powered Tools
Hydraulic Jack
Chain Hoist

FUTURE TRENDS AND CONCERNS

Use of Automated Handling Equipment
Use of Automated Welding Equipment
Environmental Concerns

COMPETENCY PROFILE

Welding Technician

Prepared by
Central Florida Community College

and
Emergency One, Inc.

December 1995

WELDER... Interpret drawings; cut and prepare materials; layout and fitup work, select and setup welding devices; and perform welding operations necessary to produce a workpiece fabricated to standard.

Duties	Tasks												
A Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Support all safety practices and use protective equipment	A-4 Demonstrate an understanding of proper hazardous material handling	A-5 Know first aid and CPR	A-6 Practice safety in the use of tools	A-7 Wear personal safety equipment	A-8 Maintain safe work station	A-9 Protect from ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot-work"
B Practice Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans and procedures to maintain quality								
C Work Ethic	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D Demonstrate Communication Skills	D-1 Be an active listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Be able to document manufacturing procedures	D-4 Be able to prepare recommendations for continuous improvement	D-5 Summarize and prioritize work responsibilities	D-6 Be able to give and follow directions and accept constructive criticism	D-7 Be able to verbally communicate with co-workers and management						
E Work as a Team	E-1 Understand the roles of co-workers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Interconvert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purposes of analysis and problem-solving							
G Oxyacetylene Welding and Cutting	G-1 Identify and describe the function of each piece of equipment	G-2 Identify the safety hazards	G-3 Describe preventive and/or protective measures	G-4 List the welding variables and describe their effects on weld quality	G-5 Describe the AWS Oxy-fuel Gas Welding Rod Classification System	G-6 Describe techniques for preventing or reducing welding related distortion	G-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	G-8 List the variables associated with cutting	G-9 Cut mild steel plate in a safe manner				
H Gas Metal Arc Welding (GMAW)	H-1 Identify GMAW equipment	H-2 Identify the safety hazards	H-3 Describe the preventive and protective measures	H-4 Identify welding variables and their effects upon weld quality	H-5 Troubleshoot equipment	H-6 Describe AWS Electrode Classification System	H-7 Describe Aluminum Assoc.'s Metal Classification System for aluminum alloys	H-8 Describe most common weldability problems associated with aluminum and copper alloys	H-9 Perform GMAW fillet and groove welds on T and butt joints on various metals in various positions	H-10 Demonstrate Aluminum GMAW Flat Horizontal, Vertical & Overhead	H-11 Describe GMAW Filler Wires	H-12 Demonstrate ability to repair welds	
I Gas Tungsten Arc Welding (GTAW)	I-1 Identify GTAW equipment	I-2 Identify the safety standards	I-3 Describe the preventative and protective measures	I-4 Identify the welding variables and their effects upon weld quality	I-5 Troubleshoot equipment	I-6 Describe AWS Electrode Classification System	I-7 Describe AWS Filler Metal Classification System	I-8 Describe the Plasma Arc Cutting (PCA) process	I-9 Perform GTAW fillet & groove welds on T and butt joints on various metals in various positions				
J Structural Layout and Fit-Up	J-1 Identify various structural shapes and their respective parts	J-2 Identify structural components & support frameworks of buildings & their components	J-3 Describe proper placement of stiffeners and supports when modifying existing structure	J-4 Identify fillet weld size for various thicknesses of base metals	J-5 Describe proper cutting sequence when cuting various structural shapes to structural drawing specifications	J-6 Describe methods for layout slopes and rolling tolerance	J-7 Describe the use of jigs and fixtures in layout and fit-up	J-8 List the steps to be followed when planning a job	J-9 Interpret structural detail sheets	J-10 Describe methods for straightening & removing damaged structural & machinery parts			

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Duties	Tasks												
K GMAW Pipe	K-1 Describe AISI stainless steels classification system	K-2 Describe weldability problems associated with straight chromium & chromium nickel stainless steels	K-3 Describe detrimental effects of vibration on the life of piping systems	K-4 Describe methods of minimizing detrimental effects of high pressure & heat on life of piping systems									
L Emergency Vehicle Terminology	L-1 Display a general understanding of emergency vehicle terminology	L-2 Understand the functions of equipment being assembled	L-3 Understand how components relate as a total system										
M Wellness/ Physical Abilities	M-1 Demonstrate ability to lift 50 pounds	M-2 Demonstrate ability to tolerate heights up to 100 feet	M-3 Ability to work from various positions, while standing on concrete for extended periods	M-4 Display ability to work in hot/cold environment for 8-10 hours	M-5 Present a history of documented regular attendance at work	M-6 Apply wellness information to lifestyle to maintain health							

SKILLS AND KNOWLEDGE

Communication Skills
Use Measurement Tools
Use Inspection Devices
Mathematical Skills
Reading/Writing Skills
Knowledge of Safety Regulations
Practice Safety in the Workplace
Organizational Skills
Mechanical Aptitude
Ability to Comprehend Written/Verbal Instructions
Basic Knowledge of Fasteners
Ability to Work as Part of a Team
Converse in the Technical Language of the Trade
Knowledge of Occupational Opportunities
Knowledge of Employee/Employer Responsibilities
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Practice Quality-Consciousness in Performance of the Job

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TRAITS AND ATTITUDES

Strong Work Ethic
Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Awareness
Motivation
Responsible
Physical Ability
Professional
Trustworthy
Customer Relations
Personal Ethics

TOOLS AND EQUIPMENT

Mechanic's Tools (e.g., toolbox, wrenches, sockets, hammers, etc.)
Measuring Tools
Power Tools
Drill Presses
Power Saws
Power Drills
Hydraulic/Arbor Press
SMAW Equipment
GMAW Equipment
Plasma Arc Cutter
Oxyacetylene Equipment
Air Carbon Arc Cutter
Exothermic Rod Cutter (Mini Torch)
Track Torch
Alignment/Calibration Tools
Computer
Forklift
Personal Safety Equipment
Workbenches
Vises
Pedestal Grinders
Air Compressor
Air Powered Tools
Hydraulic Jack
Chain Hoist

FUTURE TRENDS AND CONCERNS

Use of Automated Handling Equipment
Use of Automated Welding Equipment
Environmental Concerns

COMPETENCY PROFILE

Welding Technician

(Entry Level)

Prepared by

Central Florida Community College

and

Emergency One, Inc.

December 1995

WELDER (Entry Level) Interpret drawings; cut and prepare materials; layout and fitup work, select and setup welding devices; and perform welding operations necessary to produce a workpiece fabricated to standard.

Duties ← **Tasks** →

Duties	A-1	A-2	A-3	A-4	A-5	A-6	A-7	A-8	A-9	A-10	A-11	A-12	A-13
A Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Support all practices and use of protective equipment	A-4 Demonstrate an understanding of proper hazardous material handling	A-5 Know first aid and CPR	A-6 Practice safety in the use of tools	A-7 Wear personal safety equipment	A-8 Maintain safe work station	A-9 Protect from ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot-work"
B Practice Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans and procedures to maintain quality								
C Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D Demonstrate Communication Skills	D-1 Be an active listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Be able to document manufacturing procedures	D-4 Be able to prepare recommendations for continuous improvement	D-5 Summarize and prioritize work responsibilities	D-6 Be able to give and follow directions and accept constructive criticism	D-7 Be able to verbally communicate with co-workers and management						
E Work as a Team	E-1 Understand the roles of co-workers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Interconvert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purposes of analysis and problem-solving							
G Determine Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications	G-5 Read welding procedure								
H Understand Blueprinting and Layout	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols						
I Set-up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test-weld to verify parameters								
J Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									

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Duties ⟵ **Tasks** ⟶

Duties													
K Perform GMAW Short Circuit Transfer	K-1 Pre-heat joint	K-2 Initiate welding process	K-3 Perform weld sequence	K-4 Control weld technique	K-5 Maintain pre-heat	K-6 Perform interpass preparation	K-7 Apply welder's identification	K-8 Control post-weld temperature according to procedure	K-9 Post-clean weld	K-10 Post finish weld	K-11 Describe GMAW Filler Wires	K-12 Describe basic weld discontinuities	K-13 Demonstrate Aluminum GMAW Flat Horizontal, Vertical and Overhead
L Perform GMAW Pulse Spray Transfer	L-1 Pre-heat joint if required; understand joint preparation	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Demonstrate GMAW of aluminum, flat, horizontal, vertical & overhead positions	L-5 Maintain pre-heat	L-6 Perform interpass preparation	L-7 Apply welder's identification	L-8 Control post-weld temperature according to procedure	L-9 Post-clean weld				
M Perform In-Process Weld Inspection	M-1 Check weld size	M-2 Perform visual inspection											
N Perform In-Process Rework	N-1 Pre-heat weld (if required)	N-2 Remove weld defect and prepare for re-weld	N-3 Verify defect removal	N-4 Perform re-weld	N-5 Repeat in-process inspection								
O Perform Housekeeping Activities	O-1 Return unused consumables	O-2 Store tools	O-3 Secure welding equipment	O-4 Secure welding gases	O-5 Clean work area(s)								
P Emergency Vehicle Terminology	P-1 Display a general understanding of emergency vehicle terminology	P-2 Understand the functions of equipment being assembled	P-3 Understand how components relate as a total system										
Q Wellness/ Physical Abilities	Q-1 Demonstrate ability to lift 50 pounds	Q-2 Demonstrate ability to tolerate heights up to 100 feet	Q-3 Ability to work from various positions, while standing on concrete for extended periods	Q-4 Display ability to work in hot/cold environment for 8-10 hours	Q-5 Present a history of documented regular attendance at work	Q-6 Apply wellness information to lifestyle to maintain health							

SKILLS AND KNOWLEDGE

Communication Skills
Use Measurement Tools
Use Inspection Devices
Mathematical Skills
Reading/Writing Skills
Knowledge of Safety Regulations
Practice Safety in the Workplace
Organizational Skills
Knowledge of Company Policies/Procedures
Mechanical Aptitude
Ability to Comprehend Written/Verbal Instructions
Basic Knowledge of Fasteners
Ability to Work as Part of a Team
Converse in the Technical Language of the Trade
Knowledge of Occupational Opportunities
Knowledge of Employee/Employer Responsibilities
Knowledge of Company Quality Assurance Activities
Practice Quality-Conscientiousness in Performance of the Job

TRAITS AND ATTITUDES

Cost Conscientiousness
Empowerment of Employees
Strong Work Ethic
Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Conscientious
Motivation
Responsible
Physical Ability
Professional
Trustworthy
Customer Relations
Personal Ethics

TOOLS AND EQUIPMENT

FUTURE TRENDS AND CONCERNS

TEXAS STATE TECHNICAL COLLEGE WACO
MAST PROGRAM REPRESENTATIVES

DR. HUGH ROGERS
Director

DR. JON BOTSFORD
Assistant Director

JOE PENICK
Project Coordinator

TERRY SAWMA
Research Coordinator

WALLACE PELTON
Site Coordinator

ROSE MARY TIMMONS
Senior Secretary/Statistician

Furnished By:

RICKY FLAK
Vice President - Operations

NICK NICHOLS
Manufacturing Manager - Diamond Products

CRAIG REDDEBASE
Welder

Texas State Technical College Waco

COMPETENCY PROFILE

Welder

Prepared By
M.A.S.T.
Machine Tool Advanced Skills Technology Program
and
Consortia Partners
(V.199J40008)

Texas State Technical College Waco

SMITH GEODIAMOND

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WELDER .... interpret drawings; cut and prepare materials; layout and fitup work; select and setup welding devices; and perform welding operations necessary to produce a workpiece fabricated to standard.

Duties	Tasks												
A — Practice Safety	A-1 Follow safety manuals and all safety regulations/ requirements	A-2 Set up and use welding equipment	A-3 Wear personal safety equipment	A-4 Maintain a clean and safe work environment									
B — Determine Weld-Related Requirements	B-1 Interpret drawings and blueprints	B-2 Perform measurement and inspection	B-3 Analyze Bill of Materials (BOM)	B-4 Set-up welding process(es)	B-5 Identify electrical fundamentals								
C — Layout and Fitup	C-1 Use jigs and fixtures in layout and fitup	C-2 Prepare joints for welding with oxy-fuel, plasma arc and/or air carbon arc	C-3 Identify the various structural shapes and the preparation of same for layout and fitup	C-4 Identify methods for straightening and removing damaged structural and machinery parts	C-5 Prepare joints for welding with mechanical means	C-6 Perform post-fabrication activities							
D — Perform Shielded Metal Arc Welding (SMAW)	D-1 Identify SMAW welding variables	D-2 Identify the various types of SMAW power sources	D-3 Properly select the correct electrodes for various AISI steels and welding applications	D-4 Perform SMAW on a steel plate to a satisfactory quality level	D-5 Perform in-process re-work	D-6 Perform in-process weld inspection	D-7 Weld pipe of various materials in various positions						
E — Operate GMAW and FCAW Equipment	E-1 Identify GMAW and FCAW equipment	E-2 Match electrode material to various base metals	E-3 Identify welding variables and their effects upon weld quality	E-4 GMAW fillet and groove welds on T and butt joints with short circuit transfer method	E-5 GMAW fillet and groove welds with spray transfer method	E-6 FCAW mild steel plate with shielded and non-shielded core	E-7 Perform in-process rework	E-8 Perform in-process weld inspection					
F — Operate Gas Tungsten Arc Welding (GTAW) Equipment	F-1 Identify GTAW equipment	F-2 Match electrodes to various base metals	F-3 Identify GTAW welding variables and their effects on weld quality	F-4 GTAW fillet and groove welds on T and butt joints on various metals in various positions	F-5 Perform in-process rework	F-6 Perform in-process weld inspection							
G — Hardsurface Metal Parts and Weld Cast Iron	G-1 Hard-surface carbon and alloy steels	G-2 Identify cast steel and prepare for welding	G-3 Perform in-process rework	G-4 Perform in-process weld inspection	G-5 Hardcoat in a vacuum furnace	G-6 Braze bond materials for a multiple fill mold in a furnace	G-7 Hard patch hard surface with spray transfer						
H — Perform Oxyacetylene Welding and Cutting	H-1 Identify the function of equipment and consumables	H-2 Weld mild steel sheet metal	H-3 Brazeweld steel and cast iron	H-4 Use appropriate brazing techniques to braze various types of tubing	H-5 Cut mild steel plate								
I — Perform Air Carbon Arc (AAC) Cutting	I-1 Identify and set up the equipment associated with AAC cutting	I-2 Operate air carbon arc cutting equipment											
J — Perform Plasma Arc Cutting (PAC)	J-1 Identify and set up PAC equipment	J-2 Operate Plasma Arc Cutting equipment											

SKILLS AND KNOWLEDGE

Communication Skills
Use Measurement Tools
Use Inspection Devices
Mathematical Skills
Reading/Writing Skills
Knowledge of Safety Regulations
Practice Safety in the Workplace
Organizational Skills
Knowledge of Company Policies/Procedures
Mechanical Aptitude
Ability to Comprehend Written/Verbal Instructions
Knowledge of Cutting Fluids/Lubricants
Basic Knowledge of Fasteners
Ability to Work as Part of a Team
Converse in the Technical Language of the Trade
Knowledge of Occupational Opportunities
Knowledge of Employee/Employer Responsibilities
Knowledge of Company Quality Assurance Activities
Practice Quality-Consciousness in Performance of the Job

MORAINE VALLEY COMMUNITY COLLEGE
MAST PROGRAM REPRESENTATIVES

DR. RICHARD C. HINCKLEY

RICHARD KUKAC
Site Coordinator

Moraine Valley Community College

TRAITS AND ATTITUDES

Strong Work Ethic
Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Conscientious
Motivation
Responsible
Physical Ability
Professional
Trustworthy
Customer Relations
Personal Ethics

TOOLS AND EQUIPMENT

Machinist's Tools (e.g., calipers, dial indicators, magnetic tool holders, etc.)
Measuring Tools
Power Tools
Metal Lathe with Attachments
Drill Presses
Vertical Mill with Attachments
Power Saws
Power Drills
Hydraulic/Arbor Press
Heat Treatment Equipment
Hardness Testing Equipment
Grinding Machines with Attachments
Welding Equipment (SMAW, GMAW, FCAW)
CNC Machining Center and Turning Center
Gear Producing Machines with Attachments
Alignment/Calibration Tools
Coolant Recovery Equipment
Computer
Ventilation Equipment
Forklift
Personal Safety Equipment
Oxyacetylene Equipment
Tool Storage Equipment
Workbenches
Vises
Pedestal Grinders
Weld Test Equipment
Optical Comparator
Coordinate Measurement Machine

FUTURE TRENDS AND CONCERNS

Statistical Process Control
Composites
Laser Machining
Advanced Computer Applications
Robotics
Environmental Concerns
Fiber Optic Controls
Automated Material Handling Equipment
Computer Integrated Manufacturing

COMPETENCY PROFILE
Welder

Conducted By
M.A.S.T.
Machine Tool Advanced Skills
Technology Program
and
Consortia Partners
(V.199J40008)

Moraine Valley Community College

Standard
REFRIGERATION COMPANY

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Welder... and study arc/gas, SMAW, GMAW, GTAW, brazing, metallurgy, and print interpreation to perform welding operations necessary to produce a workpiece to required standards and/or specifications.

Duties ← **Tasks** →

A	Follow Safe Practices	A-1 Wear personal protective equipment	A-2 Identify safety rules	A-3 Familiarize safety at facility									
B	Demonstrate Technical Communication	B-1 Use standard American Welding Standard Society welding terms and definitions											
C	Interpret Welding Drawings	C-1 Review print notes, dimensions and symbols	C-2 Identify basic layout of drawings	C-3 Interpret drawing lines and views	C-4 Interpret welding symbols	C-5 Convert Metric to English	C-6 Understand print specifications	C-7 List assembly procedure per print	C-8 Understand various types of welding prints	C-9 Visualize final weldment from print	C-10 List flaws and errors on drawings	C-11 Interpret AWS standard welding symbols	
D	Basic Welding Metallurgy	D-1 Become convenant with common metallurgical terms	D-2 Describe the properties of various types of steel	D-3 List various alloys and their effect when combined with steel	D-4 Describe the effect welding has on properties of various types of carbon steels	D-5 Identify basic concepts relating to the heat affected zone							
E	Basic Shielded Metal Arc Welding (SMAW) and Oxy-Fuel Gas Cutting	E-1 Define selected welding terms per AWS A3.6	E-2 Describe AWS code for mild steel electrodes	E-3 Set up welding machine to required polarity	E-4 Use correct start and stop techniques for SMAW electrodes	E-5 Set up equipment for Shielded Metal Arc Welding	E-6 Strike an arc, run continuous stringer bead	E-7 Weld using weave technique	E-8 Weld multi-layer buildup	E-9 Set up and shut down oxy-fuel equipment	E-10 Cut steel plate using oxy-fuel equipment	E-11 Produce welds with properly fused starts and filled craters	E-12 Low hydrogen starts and stops	E-13 Design welded joints
		E-14 Weld V groove with backing in flat position	E-15 Set up air carbon arc equipment for gouging	E-16 Use air carbon arc to excavate a partial pen groove weld	E-17 Gouge to excavate defect	E-18 Make x-ray quality weld repair on a 2F position T joint 1/2" plate	E-19 Produce fillet weld on sheet steel T joints	E-20 Produce fillet welds on T joints made up to both thick and thin joint members using SMAW	E-21 Use correct starts for low hydrogen electrodes	E-22 Use correct stops for low hydrogen electrodes	E-23 Weld using large diameter SMA electrodes		
F	Advanced Shielded Metal Arc Welding (SMAW) and Cutting	F-1 Weld single V groove welds with open roots from one side	F-2 Weld various diameters of pipe to plate	F-3 Produce SMAW pipe - 5G position	F-4 Produce SMAW - 2G position groove welds	F-5 Roll weld pipe - SMAW	F-6 Produce SMAW pipe - 6G position	F-7 Create SMAW pipe to ASME Section 9	F-8 Interpret welding procedures				
G	Pipe Welding - SMAW	G-1 Produce end preparations	G-2 Fit and tack weld pipe	G-3 Roll weld open root pass on pipe - 1G position	G-4 Weld open root pipe joint - 2G position	G-5 Weld open root pipe - 5G position	G-6 Pass guided bend tests per ASME Section 9	G-7 Weld open root pipe - 2G position	G-8 Weld pipe open root passes all positions using GMAW	G-9 Weld pipe with backing using FCAW-G			
H	Gas Metal Arc Welding (GMAW)	H-1 Assemble GMAW gun and name all parts	H-2 Understand gas metal arc power source	H-3 Shielding gas application	H-4 Weld with GMAW using spray transfer	H-5 Weld with GMAW using short circuit transfer	H-6 Weld with GMAW using globular transfer	H-7 Weld with GMAW using pulsed spray transfer	H-8 Weld T joints on carbon steel using GMAW equipment	H-9 Weld multi-pass fillet welds - all positions	H-10 Weld multi-pass fillet welds - 3F vertical position	H-11 Weld multi-pass fillet welds - 4F overhead position	H-12 Weld single V groove with GMAW	H-13 Weld pipe - 1G position
I	Gas Tungsten Arc Welding (GTAW)	I-1 Understand technical aspects of GTAW	I-2 Weld fillet - 2F horizontal position	I-3 Weld fillet - 3F vertical position	H-4 Weld fillet - 4F overhead position	I-5 Weld on 1/8" material and 100% penetration	I-6 Weld 2G position using GTAW	I-7 Weld 3G position using GTAW	I-8 Weld 4G position using GTAW	I-9 Weld pipe open root passes all positions using GTAW			

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203

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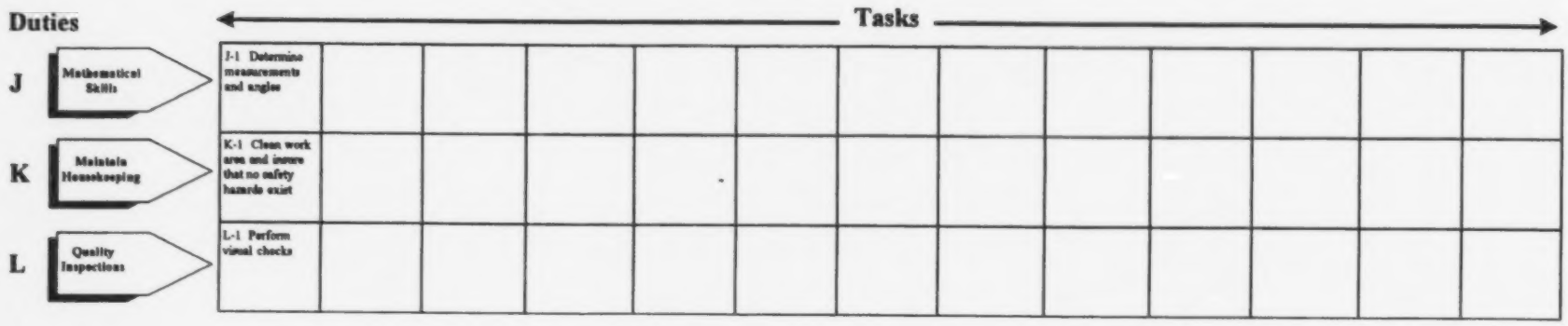
Duties
Tasks
J
Mathematical Skills
J-1 Determine measurements and angles
K
Maintain Housekeeping
K-1 Clean work area and insure that no safety hazards exist
L
Quality Inspections
L-1 Perform visual checks

Standard
REFRIGERATION COMPANY

2050 North Ruby Street
Melrose Park, Illinois 60160-1133
708 345 5400 fax 345 3513

January 8, 1996

Richard A. Kukac
Associate Dean
Business and Industrial Technology
Moraine Valley Community College
10900 S. 88th Avenue
Palos Hills, Illinois 60465-0937

Dear Dean Kukac,

Standard Refrigeration is pleased to be included in your curriculum documentation.

We would be happy to assist you in your efforts to develop a standards program nationally.

Please do not hesitate to contact us for any consideration.

Regards,

Phillip Lucas
Operations Manager

cc: Jeff Levin
David Goldberg

APPENDIX B - PILOT PROGRAM NARRATIVE

What follows is a narrative of the pilot program which was conducted for this particular occupational specialty.

August 7, 1996

Mr. Waliace Pelton
Site Coordinator
Texas State Technical College
3801 Campus Drive
Waco, TX 76705

Re: Testing of Welding Students in the Pilot Program

Dear Mr. Pelton:

Every effort was made to fulfill the expectations of the MAST Pilot Project with respect to the pre- and post-testing process of Moraine Valley Community College's Welding students. However, in order to fully appreciate the test outcomes, one must be familiar with Moraine Valley's program.

The Welding program, at Moraine Valley, is an open enrollment program and generally follows the course material of the MAST Pilot program. As a result of the open enrollment policy, there is not an identifiable cohort of students who enter the program each year and matriculate through the program. In fact, many students enroll in only one course each semester and take several years to achieve their degree. As a result, only 19 new students were available to be administered the pre-test in the Fall of 1995. As a group, the test scores ranged from 13% to 45% with an average score of 26%.

Sixteen (16) students completed the course of study and achieved a 70% or better on their exit exam. The scores ranged from 70% to 97% with an average of 86.43% and all sixteen (16) students proceeded to the next level of welding courses in the 1996 Spring semester.

Please feel free to call me if you require further clarification on the testing process.

Sincerely,

Richard A. Kukac
Associate Dean
Business and Industrial Technology

For more information:

MAST Program Director
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